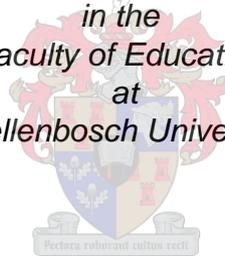


**DESIGNING A WHATSAPP VCOP MODEL TO SUPPORT THE EFFECTIVENESS OF
BLENDED-LEARNING TEACHER PROFESSIONAL LEARNING SCIENCES SHORT
COURSES**

by

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in the
Faculty of Education
at
Stellenbosch University*



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DECLARATION

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Pauline Wilna Hanekom

December 2019

ABSTRACT

A significant challenge globally is academic and professional skills development support of participants in blended-learning teacher professional learning (TPL) short courses. Communities of practice (CoPs) have been widely used in educational settings to offer collective, professional learning support. In many rural areas of South Africa the physical remoteness of schools affects the feasibility of physical CoPs. Virtual communities of practice (VCoPs) can potentially be an effective way to support participants in these settings. Little is however known about the ways in which VCoPs can support participants or how to effectively design, implement and maintain such VCoPs. This Design-Based Research (DBR) study offers findings that inform both these gaps in knowledge.

In DBR studies a Hypothetical Learning Trajectory (HLT) usually guides the investigation of how a concept is learned. In this study a Hypothetical Support Trajectory (HST) was conceptualised to guide the investigation of how academic support can be offered. Six support goals were identified, informing six sub-research questions that ultimately informed a main research question and a main design question. Within the DBR methodology a mixed method approach was followed. WhatsApp groups were chosen as platform for the VCoPs after careful consideration of theory and practicality. Three iterative cycles were designed, implemented and evaluated, both formatively and retrospectively summative. A survey, individual interviews and downloading of the WhatsApp group messages produced quantitative and qualitative data. The quantitative data were analysed via frequency distribution tables and graphs, while the qualitative data were analysed by means of thematic framework analysis.

The findings confirm the effectiveness of the use of WhatsApp groups as platform for VCoPs, give insights into the different ways in which different models of VCoPs can support academic and professional skills learning, and present fourteen design principles for the effective design, implementation and maintenance of such VCoPs.

SAMEVATTING

'n Groot uitdaging wêreldwyd is akademiese en professionele vaardigheidsontwikkeling- ondersteuning van deelnemers aan gemengde-leer Onderwyser Professionele Leer kortkursusse. Praktykgemeenskappe, wat kollektiewe, professionele leerondersteuning bied, word wyd gebruik in opvoedkundige omgewings. In baie landelike gebiede van Suid-Afrika beïnvloed die fisiese afstande tussen skole egter die lewensvatbaarheid van fisiese praktykgemeenskappe. Virtuele praktykgemeenskappe (VPGs) kan potensieel 'n effektiewe manier wees om deelnemers in hierdie omgewings te ondersteun. Min is egter bekend oor die maniere waarop VPGs deelnemers kan ondersteun of hoe om sulke VPGs effektief te ontwerp, te implementeer en in stand te hou. Hierdie Ontwerpgebaseerde Navorsingstudie (OGN) bied bevindings wat beide hierdie leemtes in kennis toelig.

In OGN-studies lei 'n Hipotetiese Leertrajek (HLT) gewoonlik die ondersoek na maniere waarop 'n konsep aangeleer word. In hierdie studie is 'n Hipotetiese Ondersteuningstrajek (HOT) gekonseptualiseer om die ondersoek na die maniere wat opvoedkundige ondersteuning gebied kan word, te lei. Ses ondersteuningsdoelwitte is geïdentifiseer, wat ses sub-navorsingsvrae toelig, om uiteindelik 'n hoofnavorsingsvraag en 'n hoofontwerpvrage toe te lig. Binne die OGN-metodologie is 'n gemengde-metode benadering gevolg. WhatsApp groepe is as platform vir die VPGs gekies na deeglike oorweging van teorie en praktiese toepaslikheid. Drie iteratiewe siklusse is ontwerp, geïmplementeer en beide formatief en terugwerkend summatief geëvalueer. 'n Opname, individuele onderhoude en die aflaai van WhatsApp groepsboodskappe het kwantitatiewe en kwalitatiewe data opgelewer. Die kwantitatiewe data is ontleed via frekwensieverdelingstabelle en grafieke, terwyl die kwalitatiewe data deur middel van tematiese raamwerk-analise ontleed is.

Die bevindings bevestig die effektiwiteit van die gebruik van WhatsApp groepe as platform vir VPGs, gee insig in die verskillende maniere waarop verskillende modelle van VPGs akademiese en professionele vaardighede kan ondersteun, en bied veertien ontwerpbeginsels vir die effektiewe ontwerp, implementering en instandhouding van sulke VPGs.

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He giveth power to the faint; and to them that have no might he increaseth strength... But they that wait upon the LORD shall renew their strength; they shall mount up with wings as eagles; they shall run, and not be weary; and they shall walk, and not faint.

(Isaiah 40: 29 & 31, King James Version)

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DEDICATION

Dedicated to the memory of my two fathers, Johan Cavanagh Rautenbach (1952 – 2007) and Carel Jacobus Adriaan Victor (1947 – 2008). I wish you were both still here to share in this achievement.

ACRONYMS, ABBREVIATIONS AND WRITING CONVENTION

Acronyms/ Abbreviations	Description
BCE	Before the Current Era
CASCADE-SEA project	Computer Assisted Curriculum Analysis, Design and Evaluation for Science Education in Africa
CDE	South African Centre for Development and Enterprise
CELEMUS	Centre for Education Leadership and Management
CoP	Community of Practice
DBE	South Africa's National Department of Basic Education
DBR	Design Based Research
ETUCE	European Trade Union Committee for Education
HLT	Hypothetical Learning Trajectory
HST	Hypothetical Support Trajectory
ICT	Information Communication Technology
IMSTUS	Institute for Mathematics and Sciences Teaching at Stellenbosch University
ISPFTED	Integrated Strategic Planning Framework for Teacher Education and Development
ITE	Initial Teacher Education
LE	Learning Enhancement
NCED	Northern Cape Education Department (South African provincial department)
NOS	Nature of Science
PCK	Pedagogical Content Knowledge
PLC	Professional Learning Community
QDAS	Qualitative data analysis software
REQV	Relative Education Qualification Value
SRQ	Sub-research question

SUNCEP	Stellenbosch University Centre for Pedagogy
TPL	Teacher Professional Learning
TSPCK	Topic Specific Pedagogical Content Knowledge
USA	United States of America
WCED	Western Cape Education Department (South African Provincial Education Department)

Writing convention

To increase readability in the analyses chapters (Chapters 5 and 6), Wenger's (1998) essential traits of CoPs, Murillo's (2008) concurrent sub-themes and the qualitative themes emerging from the data, appear in italics, except where they appear in section headings.

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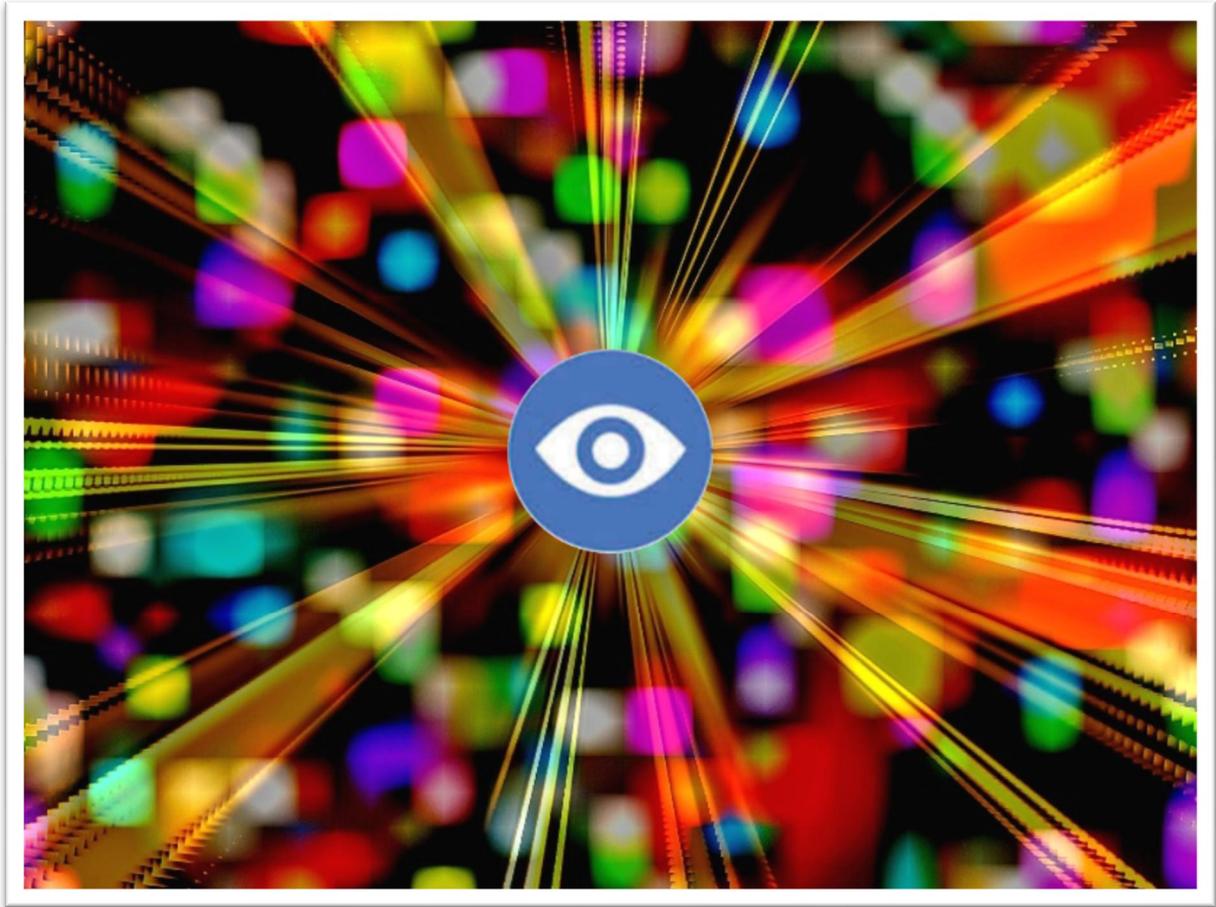
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FOCUS

CHAPTER 1: BACKGROUND AND RATIONALE

"Social media spark a revelation that we, the people, have a voice, and through the democratization of content and ideas we can once again unite around common passions, inspire movements, and ignite change."

Brian Solis (2011, p. 7)

1.1 Introduction

This chapter outlines the background, rationale and physical location of the study. Central concepts such as virtual communities of practice, teacher access to virtual platforms in South Africa and the context and necessity of Teacher Professional Learning (TPL) in South Africa, are described. The significance of the study and a statement of the research questions and objectives of the study follow. Clarification is given on the research design, the ethical considerations, limitations and delimitations, and a definition list of key terms is provided. The chaptering of the study concludes this chapter. Figure 1.1 provides a detailed outline of this chapter.

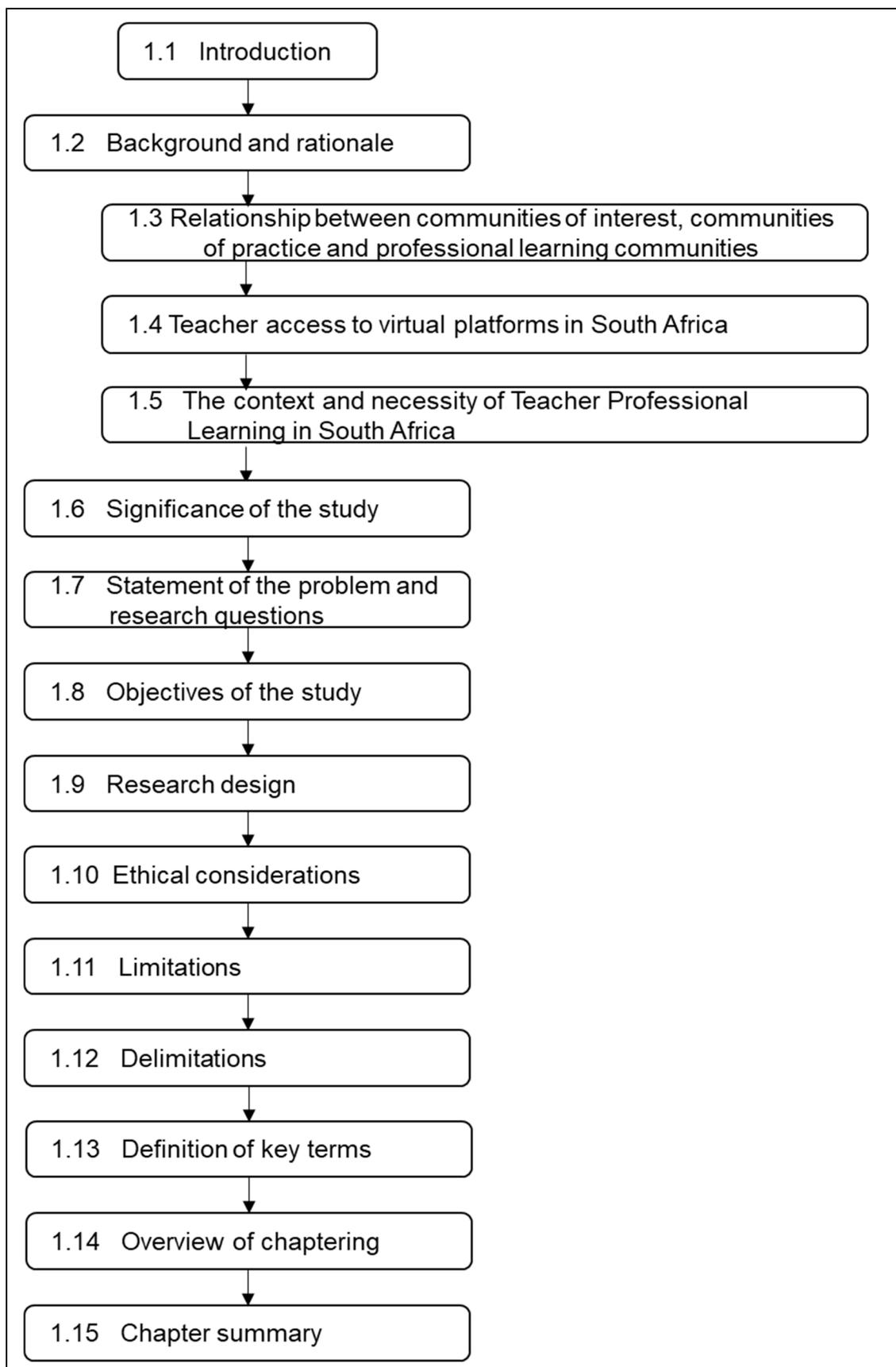


Figure 1.1: Chapter 1 outline.

1.2 Background and rationale

A significant challenge globally is academic and professional skills development support of participants in blended-learning teacher professional learning (TPL) short courses (c.f. Brodie, 2013; Wenger, 1998). Communities of practice (CoPs) have been widely used in educational settings to offer collective, professional learning support. These CoPs are seen as platforms where facilitator-participant support evolves into peer-peer support between participants; the principal aim being to increase the opportunities for implementation and integration of didactic skills and content knowledge obtained during the course, into classroom practice. This need for collaboration and support also exists in the South African educational context, as highlighted by Brodie (2013) and Maistry (2008). It is also echoed in *the Integrated Strategic Planning Framework for Teacher Education and Development in South Africa: 2011-2025*, with one of the main goals being the establishment of “Professional Learning Communities (PLCs) to strengthen teacher professionalism” (Department of Higher Education & Department of Basic Education, 2011, p. 14). The 21st century workplace’s organisational structures depend on team-based projects and the ability to work together has become a critical skill (Barron, 2000). There is thus a need to develop collaboration in the workplace. Developing this critical skill should therefore fall within the scope of effective teacher professional development.

Stellenbosch University Centre for Pedagogy (SUNCEP) came into existence in 2013 as an amalgamation of two former centres: The Centre for Education Leadership and Management (CELEMUS) and the Institute for Mathematics and Science Teaching (IMSTUS). SUNCEP, situated within the Faculty of Education, is responding to the general challenges in education in South Africa by providing two support components. TPL is provided to teachers in upper primary and secondary levels (Grades 7-12) through accredited training courses in the teaching of Mathematics and Sciences. Furthermore, school leaders and district officials may enrol in different leadership and management courses. SUNCEP provides the Learning Enhancement (LE) component through a pipeline assistance approach to learners from Grades 7 – 12. LE provides these learners with assistance through tutoring (after school / weekend / vacation schools) to deal with backlogs in specific subjects¹.

¹ <http://www.sun.ac.za/english/faculty/education/suncep/about-us>

One of the main foci of SUNCEP is in-service TPL in Southern Africa, specifically in the areas of Mathematics, Sciences, and Educational Leadership and Management. Consequently, our students are adult, in-service, qualified teachers, drawn mainly from communities historically disadvantaged by the former apartheid political system in South Africa. Although South Africa has made much progress since the democratisation of South Africa in 1994, many of these communities' access to education and educational resources are still not on par with those of the historically advantaged communities. Many difficulties affect teachers teaching in historically disadvantaged communities. These difficulties include poor teacher academic training, disinterested and unmotivated learners, overcrowding in schools and at home, dependence on public transport to attend TPL short courses and lack of aftercare for their children during TPL short courses, to name but a few (Johnson, Hodges, & Monk, 2000; OECD, 2019). For in-service teachers full-time study is naturally challenging or even impossible. SUNCEP therefore structures its courses as short courses or part-time certificates and diplomas.

In an effort to address both the monetary feasibility of courses for SUNCEP and to shorten physical contact time for teachers, our TPL short courses have been following a mixed mode (i.e. blended-learning) approach of combining face-to-face contact sessions during school vacations with e-lessons, assignments and school-based mentoring events during school terms. This approach is rooted in an analysis of 51 independent effects from 46 different online-learning studies that revealed that, when students combined both online and face-to-face elements, they outperformed those taking either entirely face-to-face instruction or entirely online instruction (Means, Toyama, Murphy, Bakia, & Jones, 2009).

Facilitators and teachers experienced the intervals between face-to-face sessions as blank spaces. These spaces were only interrupted by text messages via bulk Short Message Service (SMS) and emails from the facilitators to the students as reminders of important dates and events. In answer to this perceived need, SUNCEP introduced telematic broadcasts to enhance the learning environment. From the studio at the Interactive Telematics Services (iTS) at Stellenbosch University, lectures are broadcasted to learning centres all over Southern Africa. Most learning centres are located at secondary schools or other universities, and consist of a classroom with a satellite decoder and a television (or a projector and screen setup). This gives teachers the opportunity to attend certain lectures at their own schools, or schools within their community, after school hours. Essa (2010) found that, although students acknowledged that telematics saved them travelling expenses and increased their capacity to attend lectures, they expressed the need for dialogical

teaching and learning. This is due to telematics broadcasts being perceived as predominantly monological (from facilitator to student), as the only feedback mechanism at the time was SMS's. The need for better feedback options in blended-learning courses were previously also identified by Heinze and Procter (2004). When SUNCEP facilitators subsequently sought more interactive communication with their TPL short course participants, the researcher identified this as a need for affordable VCoPs that provide dialogical, synchronous and asynchronous academic support.

1.3 The relationship between communities of interest (Cols), communities of practice (CoPs), virtual communities of practice (VCoPs) and professional learning communities (PLCs).

No congruence exists in the definition of the concept of a CoP, as both the concepts of "community" and "practice" are highly contested within the literature. In this study the researcher frames her understanding of a CoP on Wenger's inceptive description of a CoP as a type of learning community (Wenger, 1998) and Wenger, McDermott and Snyder's description of CoPs as:

... groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis (2002, p. 4).

CoPs are also more than mere communities of interest (Cols). CoP members share their resources, which could range from experiences and stories to tools and documents, with the aim to create a resource base for the community (Kimmerle, Thiel, Gerbing, Bientzle, Halatchliyski, & Cress, 2012). In comparison a Col's members join to interact socially around a common topic (Hu, Zhao, & Huang, 2015). An example of a CoP could therefore be a group of teachers who share a concern about the educational needs of their learners, and who feel the need to deepen their knowledge and expertise by joining a teacher professional learning CoP. In this CoP they can interact on an ongoing basis, share and reflect on lesson plans, videos of lessons, interesting learner interactions and assessment tasks. They could also discuss educational challenges and lend moral and even physical support to each other. This type of CoP can also be referred to as a professional learning community (PLC).

Stoll, Bolam, McMahon, Wallace, and Thomas (2006) suggest an internationally consensual definition of a PLC as:

“a group of people sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning oriented, growth-promoting way” with the key purpose “to enhance teacher effectiveness” (Stoll et al., 2006, p. 223, 229).

PLCs are therefore CoPs that fall specifically within an educational context. Although this study is situated within an educational context, the broader CoP term will be used to include all aspects of a CoP and not only those specifically linked to education. CoPs can form either as face-to-face (f-2-f) communities (CoPs) and/or virtually communities (VCoPs) (Murillo, 2008). In a f-2-f CoP the participants share a geographical space, e.g. teachers within one city, whereas VCoP participants can be anywhere that humans have internet access, as they communicate through a virtual platform such as Facebook or WhatsApp (Murillo, 2008; OEAS, CACP, & C21U, 2012). Please see the researcher's interpretation of the relationship between the different community types in Figure 1.2.



Figure 1.2: Relationship between the different community types.

As SUNCEP's students can be based anywhere within South Africa, this necessitated the use of an easily accessible platform, free from physical location constraints, on which to build the CoP's. In other words, there was a need for a virtual platform.

1.4 Teacher access to virtual platforms in South Africa

At the beginning of the study in 2015, data from the International Telecommunication Union² showed that only 7.72 out of every 100 South Africans had fixed broadband subscriptions, whereas there were more than 164.51 mobile broadband subscriptions per 100 South Africans. This implies that most South Africans had one or more mobile broadband subscriptions and that any virtual platform SUNCEP considered should allow for mobile broadband, rather than fixed broadband use. An example of such a virtual platform is the social media messaging platform, WhatsApp.

According to the *Digital 2019 - South Africa* report (Hootsuite, 2019), WhatsApp is the leading social media messaging platform in South Africa, both in cities and rural areas, with 90% of internet users reporting WhatsApp use. To be able to access WhatsApp an internet user firstly needs to have access to a smartphone. *The state of the ICT sector report in South Africa* (Independent Communications Authority of South Africa, 2019) defines a smartphone as a mobile phone with at least Wi-Fi connectivity, web browsing capabilities, and the ability to use applications. The report also finds that 81.72% of South Africans had access to a smartphone in 2018. The second prerequisite to be able to use the WhatsApp application is access to at least a 3G telecommunication network. Looking specifically at rural areas within the two provinces where this study's participants resided, *The state of the ICT sector report in South Africa* (Independent Communications Authority of South Africa, 2019) finds that 92% of Northern Cape residents and 95% of Western Cape residents have access to 3G.

In a study focussing on computer science students, Rambe and Bere (2013) found that the use of social media messaging services like WhatsApp heightened student participation and enhanced the formation of learning communities for knowledge creation and sharing in resource-constrained environments. It has however not been investigated yet whether Rambe and Bere's findings are transferable to adult, part-time learners, for example in-service teachers. Uzunboylu and Ozdamli (2011) did indicate that, in their study, teachers displayed above medium levels of willingness towards mobile learning (m-learning), but their study did not extend to the use of WhatsApp.

² <http://www.itu.int/net4/itu-d/icteye/>

Another variable to consider in this study was whether South African teachers had access to smartphones. In the 2012 *UNESCO Mobile Learning for teachers in Africa and the Middle East* report, mention is made of the pervasive mobile access of teachers (Isaacs, 2012). There are however no statistics available on smartphone access for South African teachers, but by ranking them within the South African Advertising Research Foundation's (SAARF) Living Standards Measure (LSM) scale, the possibility of smartphone access can be assumed. According to the SAARF's LSM scale, the minimum average monthly income for the top three income groups (LSM 8 – 10) in 2011 was R14 014³ (South African Advertising Research Foundation, 2012). The minimum monthly salary for qualified teachers in South Africa, REQV level 13 and salary level 56, was R14 427.50⁴ in 2016 (Department of Basic Education, 2016b). These place teachers within the LSM 8-10 income group. For this study, it was therefore assumed that there was a high probability that teachers had access to smartphones. As for the cost of using the WhatsApp application, it is one of the cheapest ways of sending text messages in South Africa (McKane, 2018a). McKane (2018b) did a comparison between the cost of sending a text message via Short Message Service (SMS) versus sending one via WhatsApp. On average, between cellular operators in South Africa, an SMS text message costs R0.505⁵ and a WhatsApp text message R0.00004⁶. That means an SMS text message is 12 625 times more expensive than a WhatsApp text message. Sending a 10 seconds video clip via WhatsApp costs, on average, R0.264⁷, which is still nearly half the cost of an SMS text message. It was therefore assumed that the use of WhatsApp to support teachers would not add a huge burden to teachers' budgets.

In a pilot study on one TPL short course cohort (n=32), the WhatsApp group function was introduced to both in-service teachers and facilitators. This was done in an attempt to build professional communities of practice within (and between) the participants and the facilitators, and to establish a supportive, collaborative network (Ndlovu & Hanekom, 2014). At the start of the pilot study, 29 out of 32 teachers (90.6%) had smartphones and access to WhatsApp, and mid-way through that study 31 out of 32 teachers (96.8%) had access.

³ Roughly US\$ 1,000 or €980

⁴ Roughly US\$ 1,070 or €1,000

⁵ Roughly US\$ 0,035 or €0,0022

⁶ Roughly US\$ 0,0000028 or € 0,0000025

⁷ Roughly US\$ 0,018 or € 0,016

SUNCEP also introduced WhatsApp text, image and video messaging during telematics sessions as an inexpensive tool to increase dialogue and interactivity. These promising results, as well as unintended outcomes such as teachers posting their classroom interactions showing implementation and adaptation of short course activities, led to this research study (Ndlovu & Hanekom, 2014).

1.5 The context and necessity of Teacher Professional Learning in South Africa

A growing body of literature shows that the quality of teachers determines the quality of teaching, and ultimately the performance of learners (Borman & Kimball, 2005; Goldhaber, Lavery, & Theobald, 2015; Jackson, 2014; Ndlovu, 2011). Rivkin, Hanushek and Kain (2005) deserve a mention as they determined that reducing class sizes by an average of 10 learners had an effect of less than a one standard deviation improvement in the quality of the teachers. Most of the aforementioned studies were conducted in the United States of America (USA) where teacher quality is measured by Value-Added units, in other words teachers' ability to improve their learners' test scores. The European Trade Union Committee for Education (ETUCE) (2008, p. 8) defines quality teachers as equipped with "in-depth subject knowledge, advanced pedagogical skills, reflective practice" and the skills to accommodate the needs of the individual learner and the group needs as a whole within their classrooms. These, rather than Value-Added units, better resonate with the Pedagogical Content Knowledge (PCK) that Shulman (1986, 1987) proposes quality teachers display. The ETUCE (2008) further proposes that teachers should function at a level that characterises studies at a Master's level, being equipped with competences grounded in the concept of teaching as praxis, which presupposes a nexus of theory, practice and critical reflection on their own and others' practice, rather than a linear accumulation of technical skills.

In South Africa, the Relative Education Qualification Value 13 (REQV 13)⁸ is the current level at which teachers are deemed to be qualified teachers (Department of Basic Education, 2016, p. 53). Eighty-one percent of teachers in South Africa are registered as qualified teachers: 66% on REQV 13 and 15% on REQV 14 or above according to the South African Centre for Development and Enterprise (CDE) (Simkins, 2015). The CDE used data on 400 756 South African teachers between the ages of 22 and 65, to develop a profile of the

⁸ School-leaving certificate plus three years of Initial Teacher Education (ITE)

South African teaching force in 2013 (Simkins, 2015). The CDE also found that 19% of teachers were underqualified, with only 15% having at least a 4 year post matric qualification (Simkins, 2015). Although in terms of the *Occupation Specific Dispensation agreement* of 2008, the basic teacher REQV 13 qualification should have been raised to REQV 14⁹ for all teachers by 2013, this has only been officially implemented for new teachers (Department of Higher Education & Department of Basic Education, 2011). When the DBE officially raises the REQV level for all educators, the REQV 13 educators will then also be classified as underqualified. The CDE report does not break down their analysis to differentiate teacher qualifications according to the subjects they teach.

Whereas the *2011 Trends in International Mathematics and Science Study* report's *Exhibit 7.2: Science Teachers' Formal Education* data indicated that on average 90% of Natural Sciences learners were taught by teachers who had completed a degree, the average for South Africa was only 53% (Martin, Mullis, Foy, & Stanco, 2012). According to the TIMSS 2015 report's *Exhibit 8.2: Science Teachers' Formal Education*, the number of South African Natural Sciences teachers who had completed a science degree by 2015 improved to 61%, compared to the international average of 92% (Mullis, Martin, Foy, & Hooper, 2016). The Natural Sciences feed into, and prepare learners for, amongst others Life Sciences¹⁰.

According to the *2018 NSC Diagnostic Report – Part 1*, at surface value Life Sciences appears to be in a better academic space, as 76.3% of learners taking the subject passed. However, this pass rate refers to all learners who passed the subject with an average of 30% (Department of Basic Education, 2018b). Only 51.7% of learners achieved 40% or above. Therefore nearly a quarter (24.6%) of learners that passed Life Sciences did so with an average below 40%. This has been the general trend since 2014. Please see Figure 1.3.

⁹ School-leaving certificate plus four years of ITE (e.g. Bachelors of Education degree or 3 years subject specific Bachelor's degree with a Postgraduate Certificate in Education)

¹⁰ In most other countries Life Sciences is called Biology at school level

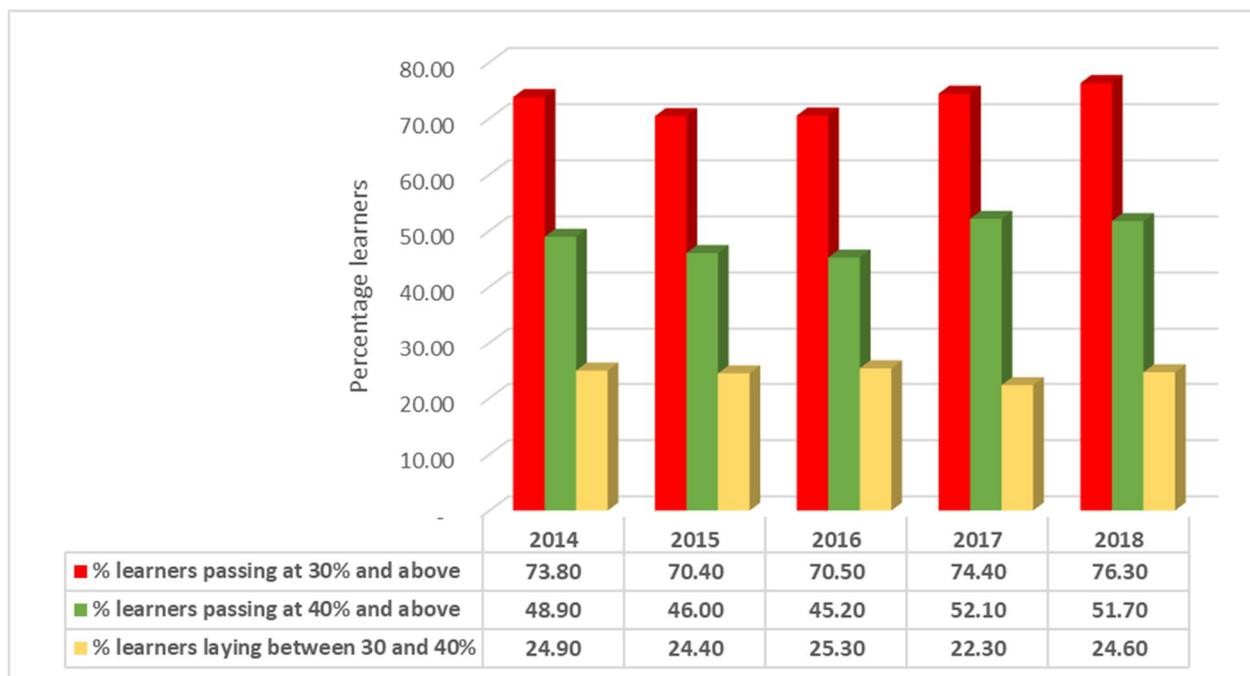


Figure 1.3: Achievement in Life Sciences during the NCS exam from 2014 - 2018. Graph adapted from *2018 NSC Diagnostic Report – Part 1, Life Sciences* (Department of Basic Education, 2018b, p. 120).

From the above-mentioned it is clear that there is a definite need for Natural and Life Sciences in-service TPL opportunities in South Africa.

One of the attempts to accelerate the achievement of the South African national education goals has been the government roll out of Operation Phakisa: Information and Communication Technology in Education (Zuma, 2015). The aim of this part of Operation Phakisa was to fast-track ICT integration in the basic education sector in answer to the 2004 *Draft White Paper on e-education: Transforming learning and teaching through information and communication technologies* (Department of Education, 2004). The main goal of the Draft White Paper is the social transformation of education to socially transform the post-apartheid South African society and ensure equal educational opportunities to all South African learners (Department of Education, 2007b). The Draft White Paper states in point 2.17:

The Department of Education believes that developments in ICTs create access to learning opportunities, redress inequalities, improve the quality of learning and teaching, and deliver lifelong learning. ICTs can accommodate differences in learning styles and remove barriers to learning by providing expanded opportunities and individualised learning experiences (Department of Education, 2004, p. 16).

This quote, as well as the Operation Phakisa guidelines, have implications for all TPL short courses, because their participants are employers of the DBE. New TPL short courses should therefore not only be ICT integrated, but also include support for the development of teachers' ICT integration and support skills. Additionally, the modes of delivery suggested for short and part-time courses offered by SUNCEP, as defined by the *Stellenbosch University's Institutional Intent and Strategy 2013 – 2018* (Stellenbosch University, 2013), are either blended or fully on-line learning formats. If SUNCEP therefore wants to continue as service provider for the DBE and Provincial Departments of Education, it is obligated to deliver ICT integrated, blended-learning format TPL short courses. In the *Integrated Strategic Planning Framework for Teacher Education and Development - 2011-2025* (ISPFTED) (Department of Higher Education & Department of Basic Education, 2011) the authors urge that it is crucial that teacher development must be supported and enabled by what they often refer to as "professional teacher learning communities" (p. 5). In the ISPFTED (Department of Higher Education & Department of Basic Education, 2011) it is also proposed that a set of guidelines be developed to not only support the creation of such communities, but also aid in the optimisation thereof. The results of this study may assist in informing the creation of such a set of guidelines.

1.6 Significance of the study

Social mobile technologies can act as boundary crossing objects between formal (e.g. TPL short courses) and informal (e.g. work-based) learning environments (Gachago, Strydom, Hanekom, Simons, & Walters, 2015; Ndlovu & Hanekom, 2014; Pimmer & Gröhbiel, 2013). An example of such a social mobile technology tool that also has the affordance of an educational support tool, is WhatsApp (Rambe & Bere, 2013; Rambe & Chipunza, 2013). WhatsApp groups can support the creation of networks between professionals isolated by distance, e.g. teachers teaching in rural areas, or context, e.g. teachers in high- and low-income schools (Gachago et al., 2015; Pimmer & Pachler, 2014). Essa (2010) and Smyth, Houghton, Cooney and Casey (2012) have shown that the non-face-to-face components of blended-learning programmes can lack sufficient student-presenter and student-student interactivity and ultimately lead to students feeling unsupported and frustrated with the blended mode of delivery. Ngulube and Mngadi (2009) note that the establishment of CoPs in South African higher education institutions are encouraged, but not yet actively supported by their institutions. Referring to VCoPs as emergent technologies in higher education, Bozalek, Gachago, Alexander, Watters, Wood, Ivala and Herrington (2013) suggest that there are extensive possibilities for research into their appropriate and optimal use.

The knowledge contributions of this study are: to inform methodology through the analytical pleuristic DBR approach used in Chapter 5, secondly, to add to design theory through the study's conceptualisation of a hypothetical support trajectory (HST) and thirdly, to inform practice through the study's resultant design principles for academically supportive VCoPs.

1.7 Statement of the problem and research questions

This study is motivated by the researcher's occupational need to academically support in-service teachers participating in blended formats of delivery of TPL short courses at SUNCEP. These short courses aim to improve the pedagogical content knowledge of underqualified teachers, especially in disadvantaged parts of the country. Many of these teachers teach in rural schools, far from other short course participants and in many cases these teachers are the only Natural or Life Sciences teacher in their individual schools.

The main **research question** is:

How can WhatsApp be optimally utilised to support the effectiveness of blended-learning formats of Natural and Life Sciences TPL short courses? Effectiveness is measured against Guskey's (2002) five levels of professional development effectiveness.

This leads to a main **design question**:

Which design principles optimise support via WhatsApp VCoPs of the effectiveness of blended-learning formats of Natural and Life Sciences TPL short courses?

The following sub-questions further guide the study:

- Sub-research question 1: Which essential traits of a virtual community of practice (VCoP) were fostered in each WhatsApp VCoP?
- Sub-research question 2: In what ways did each WhatsApp VCoP support the initial satisfaction of teachers in the TPL short courses?
- Sub-research question 3: In what ways did each WhatsApp VCoP support teacher learning in the TPL short courses?
- Sub-research question 4: In what ways did each WhatsApp VCoP provide organisational support in the TPL short courses?

- Sub-research question 5: In what ways did each WhatsApp VCoP support teachers to implement new knowledge and skills gained during the TPL short courses, in classroom practice?
- Sub-research question 6: In what ways did each WhatsApp VCoP support TPL short course impact on learner performance?

1.8 Objectives of the study

This study's objectives are to:

- formulate three models to utilise WhatsApp as VCoP platform to support blended-learning Natural and Life Sciences TPL short courses;
- implement these models with in-service Natural and Life Sciences teachers participating in TPL short courses;
- collect data during each implementation iteration (build cycle), analyse data, adapt the model based on results from the analysis of the data;
- determine which design principles inform VCoPs that support the effectiveness of TPL short courses.

These objectives appear to be part of a sequential process, but form part of a Design-Based Research (DBR) cyclical and iterative design process.

1.9 Research design

Educational research is usually classified as either research-about-education or research-for-education. Juuti and Lavonen (2006) interpret the former as having an intellectual objective to make theoretical sense of teaching and learning, and the latter as having a pragmatic objective to enhance teaching and learning praxis. Heap (1992) distinguishes in social sciences research, under which educational research falls, between research-as-science and research-as-project. Research-as-science aligns to recognised and consistent theoretical frameworks, whereas research-as-project links across conceptual frameworks, leading to a need for mixed formats and methods. Design-Based Research (DBR) as such a dual-purpose research type (Mohrman & Lawler III, 2011), combines the aims of developing "innovative educational environments" (Brown, 1992, p. 141) with the development of practice-relevant theories (Euler, 2017) within an iterative design process (Figure 1.4).

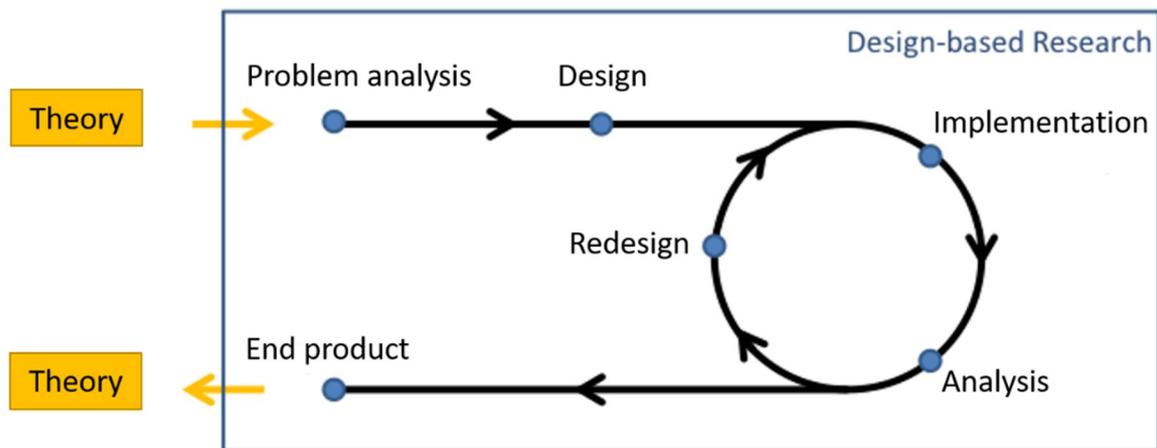


Figure 1.4: Diagrammatic representation of the iterative nature of DBR (Stöcklin, n.d.)¹¹

To avoid confusion between other design research and educational research acronyms, the abbreviation DBR, as per the Design-Based Research Collective (2003), will be used throughout this study. This study firstly aims to determine whether WhatsApp can be used to support the effectiveness of TPL short courses, which would fit into the mould of experimental research. Experimental research targets the implementation of theories or models in a controlled context (research-as-science). Secondly, the study also aims to find the optimal design principles for using WhatsApp to support the effectiveness of TPL short courses (research-as-project). The traditional experimental paradigm that strives for experimental control will therefore not be suitable for this study. A paradigm that focusses on both theory and the messy reality of educational contexts, where human and social phenomena are continually changing and influencing variables, is needed (Abdallah & Wegerif, 2014).

A quote that encapsulate the epistemological view of DBR comes from the playwright Sophocles in about 400 BCE, who wrote: “one must learn by doing the thing, for though you think you know it, you have no certainty until you try” (as cited in Hogue, 2013, p. 1921). Or as Cobb, Confrey, diSessa, Lehrer, and Shauble so eloquently states: “the theory must do real work” (2003, p. 10). This DBR study uses mixed methods to obtain data: Qualitative thematic framework analysis of the WhatsApp group member discussions and semi-structured interviews with purposive sampled group members, as well as a quantitative survey of all group members. The researcher agrees with Morgan (2007) that the traditional hierarchical empowerment of ontological assumptions, as found in the metaphysical

¹¹ Author permission received for use of diagram – see Addendum B

worldview, does not leave room for broad approaches, such as mixed methods. Morgan suggests that a comparison between the qualitative, quantitative and pragmatic research paradigms should rather focus on their differences in social science research methodologies. An example of this alternative focus is the pragmatic approach's connection between data and theory that Morgan describes as an abductive reasoning process. This means that the reasoning oscillates between induction and deduction, inducing theories from observation and then assessing theories deductively through action. Morgan (2014) further proposes that the pragmatic paradigm is characterised by the view that every attempt we make to understand or act in the world is intrinsically contextual, emotional and social. Morgan's view resonates with Dewey (1929) who contends that discourses that argue for "either the nature of the outside world" or "the world of our conceptions" are in reality just discourses about two sides of the same coin. In fact, the classical pragmatists Peirce, James and Dewey all oppose the view of knowledge as representation. Instead they focus on knowledge and the gaining of knowledge within the context of action (Biesta, 2007; Rorty, 1998). Peirce also contends that the function of social research should be to enable us to act more effectively and not to merely represent reality (Biesta & Burbules, 2003; Rorty, 1998). Educational DBR as methodology, as well as the use of mixed methods, are congruent with the pragmatist worldview. Through active and participatory cycles of investigation, knowledge that can be analysed both quantitatively and qualitatively is generated about users, context and content (Abdallah & Wegerif, 2014; Alghamdi & Li, 2013; Bannan, 2009; Barab & Squire, 2004; McKenney & Reeves, 2012). This knowledge thereby directly informs the design process of a technology-based learning environment. The DBR methodology within a pragmatic paradigm fits the focus of this research, namely, the creation of educationally effective TPL interventions using WhatsApp as support platform. The repeating nature of the SUNCEP TPL short courses creates ample opportunity for iterative cycles of investigative research.

As for the validity of DBR research, Habermas (1984) argues that to reach understanding, any claim should find agreement at three levels: objective, subjective and normative validity. Long (2017) argues that as these three levels can be found within both qualitative and quantitative research, validity in mixed method research can be claimed if the three levels of validity can be generated across the qualitative and quantitative components of DBR. A fourth type of validity, ecological validity that refers to whether the research has real world application or meaning, is seen as one of the characteristics of DBR (Prediger, Gravemeijer, & Confrey, 2015).

1.10 Ethical considerations

According to Wellington (2015), ethics in educational research can be described as the moral principles or guiding conduct for researchers in this field. Ethical approval for this study was obtained from the Western Cape Educational Department (WCED)¹², the Northern Cape Educational Department (NCED)¹² as well as from the Stellenbosch Research Ethics Committee: Humanities¹². Teachers, facilitators, curriculum advisors and mentors involved in the study were fully briefed as to the intentions and processes involved in the study. All participants were made aware of the possible risk of on-line harassment when joining a social media group, as well as the relevant procedures to follow in case of said harassment. Participants signed consent forms and partook voluntarily in the study. The researcher anonymised all names of schools and participants in the study.

1.11 Limitations

In postgraduate studies time is a limitation. The timeframes of DBR studies link to iterative cycles of testing and formative evaluation. The Faculty board¹³ of the Faculty of Education at Stellenbosch University decided on a five year limit to doctoral studies in the faculty (Stellenbosch University, 2019). This means that the researcher has to complete all iterative cycles of testing within this time limit. A second limitation is short course group sizes. Two factors limit SUNCEP short course group sizes for the sciences. Firstly, funding. Although SUNCEP is situated within Stellenbosch University (SU), it is not funded by SU and needs to find funding from other sources. Historically, South African teachers expect teacher professional development courses for free. Courses are therefore funded by education departments or corporates who offer funding for teacher development (SADTU Curtis Nkondo Professional Development Institute, 2017). SUNCEP has to enter into contractual agreements with funders, who then determine the cohort size they are prepared to fund. The second factor limiting group size is physical space in the form of laboratory size. The laboratories at the schools and DBE training venues used by SUNCEP usually have a limit of 40 students. SUNCEP short course group sizes are therefore usually not more than 40, but can even be less if limited by funder agreements. The above-mentioned factors limited sample sizes for the quantitative data analysis in Chapter 5 and therefore led to less conclusive results. The mixed method format of the study added a qualitative layer of

¹² See Addendum A for all relevant ethical approval documentation.

¹³ See Addendum F for a letter from the Vice-Dean Research confirming this decision.

analysis, in order to triangulate with the quantitative results to enhance generalisability. De Vries (2018) and Plomp and Nieveen (2007) argue that effective, relevant and practical solutions to educational problems can never be completely generalisable, as they should be designed for specific educational contexts.

1.12 Delimitations

A number of factors delimited participant enrolment in this study. Firstly, in line with the objectives of this study, participants had to be in-service Natural or Life Sciences teachers. Secondly, they had to be part of SUNCEP's Natural or Life Sciences TPL short courses during the period 2015 – 2017 (the timeframe of this study). Thirdly, to take part in the VCoPs, participants had to have access to smartphones and the WhatsApp application. The study did not attempt to compare single participants with one another, only the group dynamics within and between different VCoP groups. The study was also delimited within the theoretical and conceptual framework as presented in Chapter 3.

1.13 Definition of key terms

The first six key terms listed below describe individuals in this study. The following seven are TPL subject related terms and the last six terms relate to DBR.

Facilitator

In this study, a SUNCEP full-time, part-time or ad-hoc staff member that develop material, present and facilitate professional learning short courses.

Teacher

The term used in this study for educators in schools.

Learner

The term most often used for students taught by teachers in South African schools. In the Natural Sciences classes they are commonly between 13 and 15 years old. In the Life Sciences classes they are commonly between 16 and 18 years old. Due to the legacy of apartheid learners are, however, often much older.

Student

In this study, the term student specifically refers to the teachers attending TPL courses.

Mentor

In this study, a SUNCEP full-time, part-time or ad-hoc staff member that provides academic support to students during TPL courses.

Participant

In this study, a participant is defined as a member of one of the three WhatsApp groups who agreed to participate in this study. Participants are the participating teachers and education department officials attending the TPL courses, facilitators and mentors. The researcher was an active participant in all three WhatsApp groups in her capacity as facilitator.

Short course

A short learning course, less than one year in length, that does not form part of a full diploma or degree programme, but that can sometimes align to such a programme.

Meiosis

A cellular process by means of which cells divide to form reproductive cells (gametes). A process taught in the South African Life Sciences school curriculum.

States of matter

Matter (any physical substance) can take on different states, e.g. solid, liquid, gas or plasma. A concept taught in the South African Natural and Physical Sciences school curriculum.

Acid and bases

Substances with distinct chemical properties. Acids are typically corrosive and/or sour tasting, whereas bases are usually corrosive and/or soapy tasting. Concepts taught in the South African Natural and Physical Sciences school curriculum.

Periodic table of elements

The standardised format in which elements are arranged. A concept taught in the South African Natural and Physical Sciences school curriculum.

Genetics

The study of how characteristics are inherited from one organism to another. A concept taught in the South African Life Sciences school curriculum.

Genetic concepts: Phenotype, genes, genotype and alleles

The phenotype of an organism is its observable characteristics. Genes are pieces of DNA that determine some characteristic of an organism. The genotype of an organism is the set of genes of an organism that leads to the observable characteristics of that organism. Alleles are the different versions of a gene. These are all concepts taught in the South African Life Sciences school curriculum

Formative analysis

Formative evaluation is a method within DBR, used to detect the disparities between the design being tested and the ultimate design goal.

Retrospective analysis

Retrospective analysis is a method within DBR, used to determine whether the ultimate design goal has been reached.

Design principles

Design considerations emerging from design research, which guide designers in their development processes. In this study, the resulting design principles should guide designers of VCoPs that academically support students.

Hypothetical Learning Trajectory (HLT)

It is the envisioned route by which learners and students will master a particular concept and consists of the learning goal, the learning activities and the hypothetical learning process (Simon, 1995).

Hypothetical Support Trajectory (HST)

It is the envisioned route by which learners and students can be academically supported. It consists of support goals, support activities and support elements, and the hypothetical support process defined as a prediction of the enhancement of professional development effectiveness. See Chapter 4, section 4.5.1

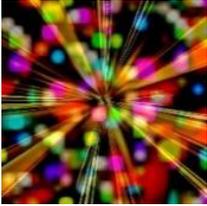
Effectiveness vs Effectivity

The root of both words, effective, means to have the desired result. Effectiveness usually refers to the degree to which something is successful in producing a desired result, while effectivity can either refer to the ability to produce a desired result or be used as a synonym for effectiveness. In this study effectiveness and effectivity are used interchangeably.

1.14 Overview of chaptering

DBR studies often do not conform to the typical chaptering found in dissertations. The seven-step Easterday, Rees Lewis and Gerber's (2017) DBR process, however, provided the researcher with a suitable way to conform with the traditional chapter layout (Table 1.1).

Table 1.1:
How the Easterday et al.(2017) seven-step DBR process informed the chapter layout.

Chapter in this study and descriptive image		DBR step and icon	Description
<p>1. Background and rationale</p> 	1	 FOCUS	<p>The intentionality of the general problem and goal that focusses the design and research, is identified and described. This includes describing the stakeholders or group that the design is intended for.</p>
<p>2. Perspectives from the literature</p> 	2	 UNDERSTAND	<p>To fully understand the focussed problem/research questions, the literature needs to inform the researcher on theoretical aspects of the problem, as well as possible solutions that has already been investigated.</p>
<p>3. Weaving a theoretical framework to guide a conceptual design</p> 	3	 DEFINE	<p>In the define step, the focussed problem/research question is placed within a theoretical framework to assist the researcher in creating (conceive phase) a conceptual design which will inform the research design.</p>
	4	 CONCEIVE	
<p>4. Research paradigm, methodology and the research design</p> 	5	 BUILD	<p>In the build step, the design of the prototypes/models, through different iterations, has to be described. In the context of a doctoral study, the research paradigm and DBR, as chosen methodology, also need to be described and its use defended.</p>

Chapter in this study and descriptive image		DBR step and icon	Description
5. Presentation, analysis and interpretation: Part 1 	6	 TEST	<p>In the test step, the formative analysis and evaluation of the data resulting from the implementation of different prototypes/models are discussed, followed by the retrospective analysis and evaluation of the data.</p>
6. Presentation, analysis and interpretation: Part 2 			
7. Presenting a Whatsapp VCoP model to support the effectiveness of blended-learning TPL short courses 	7	 PRESENT	<p>In the present step, the researcher communicates how (practical outcome) the models tested addressed the main research question. Design principles (theoretical outcome) are discussed. Recommendations for further design development or possible research are also presented.</p>

1.15 Chapter summary

In this chapter the background of, and rationale for the study, was outlined, providing focus for the study. The need for affordable VCoPs that provide dialogical and synchronous academic support to TPL short course students across South Africa, was highlighted. The researcher argued that most South African teachers have access to, and are familiar with the use of smartphones and the affordable WhatsApp application. As no congruence exists in the definitions of CoIs, CoPs and PLCs, these terms, and the term VCoP, were introduced to the reader. The context of TPL in South Africa, grounded in political history and changing policies, was discussed, highlighting not only the necessity of TPL short courses, but also the need for professional teacher learning communities of practice to support these

programmes. The researcher highlighted the need for guidelines or design principles to optimise the functioning of such CoPs. This directly informed the next section of the chapter, namely the significance of the study. The researcher argued that there is a gap in the knowledge about the design, implementation and successful formation of VCoPs within the South African TPL short course context. The researcher posed that this study aims to contribute to closing this knowledge gap. A formal statement of the problem, the main research and design questions, sub-questions, as well as the aims, in other words the elements that must guide the study, were provided. This was followed by an introduction to DBR as research design, the ethical considerations for this study, the delimitations and limitations, and finally an overview of the chaptering. In Chapter 2 perspectives from the literature that influence this study's research process, are presented.



UNDERSTAND

CHAPTER 2: PERSPECTIVES FROM THE LITERATURE

“Those who can, do. Those who understand, teach.”
(Shulman, 1986)

2.1 Introduction

In this chapter a literature review on topics that influence this study's research process is presented. This forms part of step two (show an understanding of the problem) of the Easterday, et al. (2017) seven-step iterative process for DBR. A review of current literature related to TPL programmes cannot begin without at least a basic understanding of the historical developments within teacher education, as well as the complexities of the South African teacher context. Therefore, this chapter starts by providing a brief historical overview of teacher education to show how, historically, the literature views the traits and skills needed in the teaching profession. This is followed by a review of the shifting policies and scope of Natural and Life Sciences teaching in South Africa. As professional learning aims to enact a change in teacher efficacy, the chapter then examines different teacher change models. Teacher change is an ongoing process, linking to the next reviewed topic: life-long learning. The researcher then addresses a recent paradigm shift in the format of TPL short courses, leading to a discussion on the conceptual shift from general Pedagogical Content Knowledge (PCK) to a focus on Topic Specific PCK (TSPCK). As this study's subject focus is Natural and Life Sciences, the Nature of Science (NOS) and its connection to TSPCK is then addressed. This is followed by a discussion on the TPL presentation platform shift from face-2-face to ICT environments, including an unpacking of 21st century teaching skills and the definition shift from blended-learning to ICT integration. Figure 2.1 provides a detailed outline of this chapter.

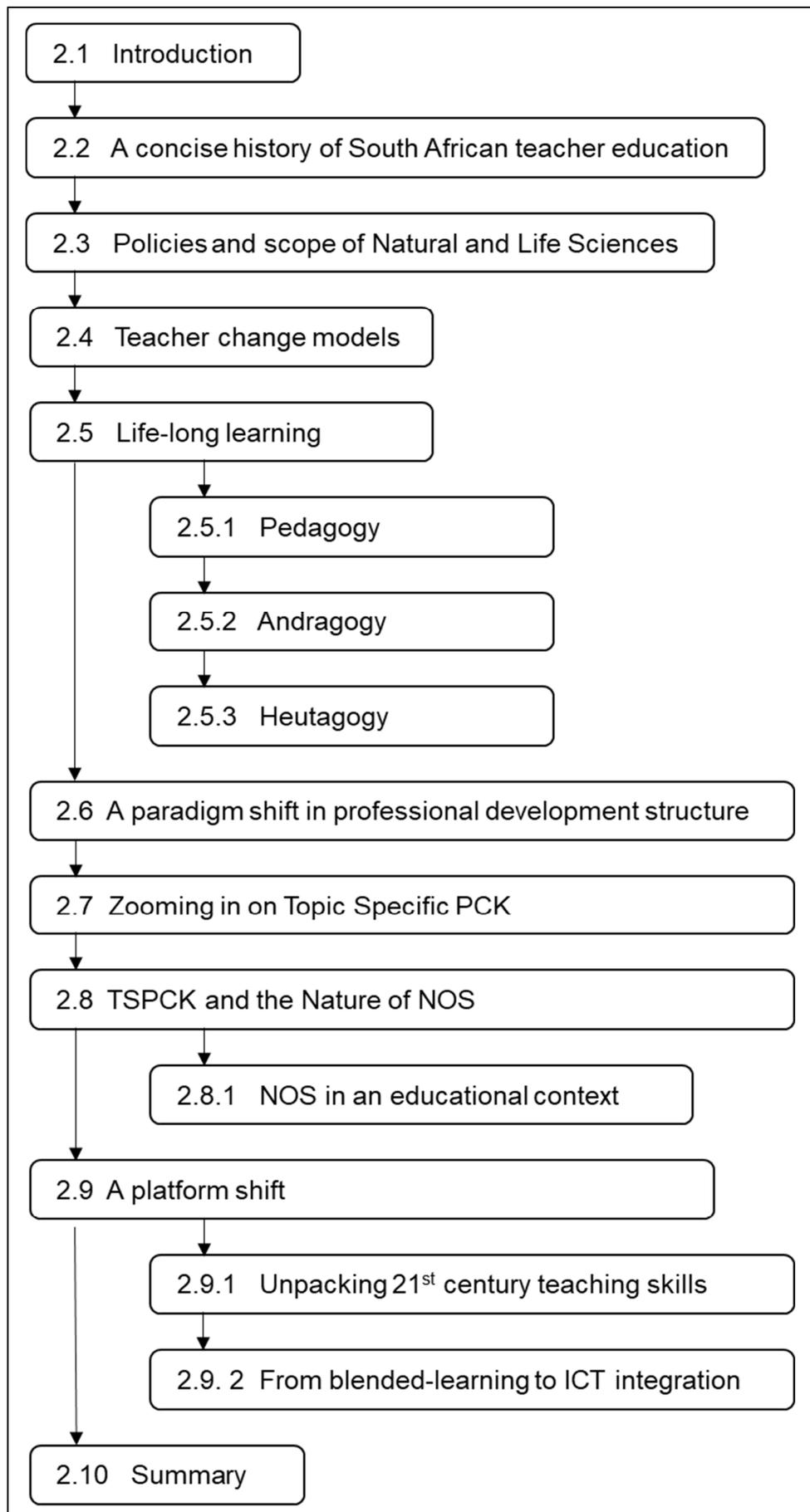


Figure 2.1: Chapter 2 outline.

2.2 From Plato to today: A concise history of teacher education from a South African lens

In ancient times teaching was seen as a process of passing on knowledge, and teacher education as a process of observation and emulation of a master (Woodring, 1975), i.e. Plato learned from Socrates and in turn, Aristotle learned from Plato. Exactly what teachers needed to know has however been a constant debate across the centuries. Aristotle, in *Metaphysics*, argued that that which discerns a person is not his content knowledge and the theory behind that knowledge, but ultimately his ability to teach (Aristotle, trans. 1896). In other words, teachers needed to have an integrated relationship between knowing and teaching. No formal teacher education institutions existed in the time of the Greeks or the Romans. However, Roman teachers could obtain advice on teaching from Quintilian, Erasmus and the *Didactica Magna* of Comenius (Woodring, 1975). In medieval¹⁴ times there was still a fundamental connection between knowing and teaching, as can be seen in the term ‘doctorate’, the highest degree offered by a university, of which the root meaning is teacher (Shulman, 1986). According to Ong (1958) and Woodring (1975), the doctoral candidate in medieval doctoral examinations had to demonstrate the ability to teach his subject to be awarded his degree. This could therefore be seen as the first form of formal teacher education, although the first institutions specialising in teacher education only arose in the seventeenth century in France (Woodring, 1975).

Before the establishment of a refreshment station at the Cape of Good Hope by the Netherlands in 1652, no formalised education system existed in the southern part of Africa that would eventually become South Africa. Until 1910, with the establishment of the Union of South Africa, most teachers for white children were imported from European countries (Wolhuter, 2006). According to Wolhuter, most non-white children were formally educated via missionary schools during this period. The first teachers’ training college in South Africa that catered for non-white South Africans was run by Moravian missionaries and opened its doors in Genadendal on 12 September 1838 (Du Preez, Van Oers, Roos, & Verhoef, 2009; Wolhuter, 2006). Interestingly, this was 58 years before the first teachers’ college for white South Africans, Wellington Teachers’ College, was established on the 26th of January 1896 (Broodryk, De Kock, & Joubert, 1989).

¹⁴ 5th to the 15th century

During the early stages of the 20th century teacher training in South Africa was racially divided to cater for different politically motivated outcomes (Asmal & James, 2001; Welch, 2002). According to Welch (2002) and Asmal and James (2001), teachers were expected to teach white and black learners in separated schools and at different educational levels: white learners to manage the labour market and black learners for a subordinate labour position. Teacher training was therefore also divided into these two streams, with teacher training colleges for whites offering professional three- and later four-year qualifications, whereas teacher training colleges for black teachers only offered two- and later three-year qualifications. Thus unequal professional qualifications were created that is still impacting schooling in South Africa in the 21st century (Asmal & James, 2001; Welch, 2002; Wolhuter, 2006).

In line with the Apartheid¹⁵ policies, education departments were segregated until, by 1990, there were seventeen different, parallel running departments (Du Toit, 1996; Naicker, 1999). In 1994 the end of the Apartheid era also saw the newly instated government prioritising a new education system (Padayachee & Harding, 2011). Their first step was to amalgamate the seventeen departments into a single national department of education. This national department was then subdivided into nine provincial departments of education (Jansen & Taylor, 2003). The approximately 150 segregated teacher training institutions providing teacher training in 1994, including 36 universities, also had to be rationalised to cut costs. By 2000 only 50 of the teacher training colleges remained. These colleges were eventually either shut down or incorporated into the remaining 22 universities (Wolhuter, 2006). Initial teacher education (ITE) in South Africa has therefore been inadequate for a large proportion of the teacher population, creating a dire need for in-service TPL programmes.

2.3 Navigating shifting policies and scope: Natural and Life Sciences teaching in South Africa

South African educators not only had to struggle to access high quality ITE, but they had to contend with an ever-changing curriculum. Since South Africa's move to democracy in 1994, the schooling system's teaching curriculum has been revised and amended extensively. Between 1994 and 2013 a total of 22 different curriculum documents and related policies saw the light of day (Sayed & Kanjee, 2013). The only full curricular change

¹⁵ The Afrikaans word Apartheid means 'apartness'. The Apartheid ideology was introduced in South Africa in 1948. Apartheid's focus was the separate development of the various racial groups in South Africa.
<http://www.sahistory.org.za/article/history-apartheid-south-africa>

was from the Apartheid era's Christian National Education (CNE), with a fundamental pedagogic philosophy, to the outcomes-based focus of Curriculum 2005 (C2005) in 1997 (Chisholm, 2005). C2005 included a set of *National Curriculum Statements* (NCS) for each subject taught in schools. In 2000 a Ministerial Review Committee produced a report on the challenges associated with C2005 (Chisholm et al., 2000) and, based on this report, the *Revised National Curriculum Statement* (RNCS) for the General Education and Training band (GET) was implemented from 2004 onwards (Dada et al., 2009). The RNCS was not a new curriculum, but a revision of C2005. The RNCS for the Further Education and Training (FET) band started rolling out in 2006 (Sayed, Kanjee, & Nkomo, 2013). After the 2009 Ministerial report on C2005, amendments to the RNCS led to implementation of the *Curriculum and Assessment Policy Statements* (CAPS) for both the GET and FET bands in 2012 (Department of Basic Education, 2011a, 2011b).

Not only did revisions occur across the entire curriculum, but certain subjects underwent content revisions in-between curriculum revisions. One example is the Biology curriculum for the FET band that had a change of name in 2006 to become Life Sciences. After the implementation of the RNCS, Life Sciences had its content specifications reworked and re-implemented in 2007 as the *New Curriculum Framework* (Department of Education, 2007; Johnson, Dempster, & Hugo, 2015). All these rapid changes occurred without proper TPL short courses to assist South African teachers in adapting to the different revisions and amendments to the curriculum, specifically in the content and skills rich subjects such as Natural and Life Sciences. Thus an urgent need for subject focussed TPL was created (Umalusi, 2014).

2.4 Finding perspective through teacher change models

Inherently TPL short courses centre on the notion of changing teachers, supporting them where ITE has failed them, or where curriculum changes expose knowledge gaps. SUNCEP's TPL short courses focus on change through participation (McLaughlin, 2013), as active participation supports the understanding and consenting components of the change process. Shalem (2003) suggests that teacher change is an interrelated process between teachers' understanding of why they should change, their consent to change and their readiness to accept and run with the change. TPL short courses, however, rarely focus on organisational support of teachers to accept and run with the change (Guskey, 2014). Fleisch (2006) and Taylor (2002) advocates for bureaucratic disciplinarian strategies to enforce teacher acceptance of, and compliance with, change. The researcher, however,

agrees with Shalem (2003, p. 48) that teacher change should be enacted through their experiencing of meaningful pedagogical interventions that have relational significance in their context, and that is supported through a "social space of interaction".

Pennington's (1995) Teacher Change Cycle is a model that attempts to describe how teachers change in reaction to input through, for example, TPL short courses. The model focusses on take-in, processing and assimilation of new information by teachers. Pennington's (1995) model suggests that teachers first need to be exposed to the procedural aspects of the proposed change, while being supported continuously to implement and to reflect on the implementation, ultimately leading to a conceptual internalisation of the change (Figure 2.2). As with Shalem (2003) and Guskey's (2014) models, Pennington's (1995) teacher change model needs organisational support to succeed.

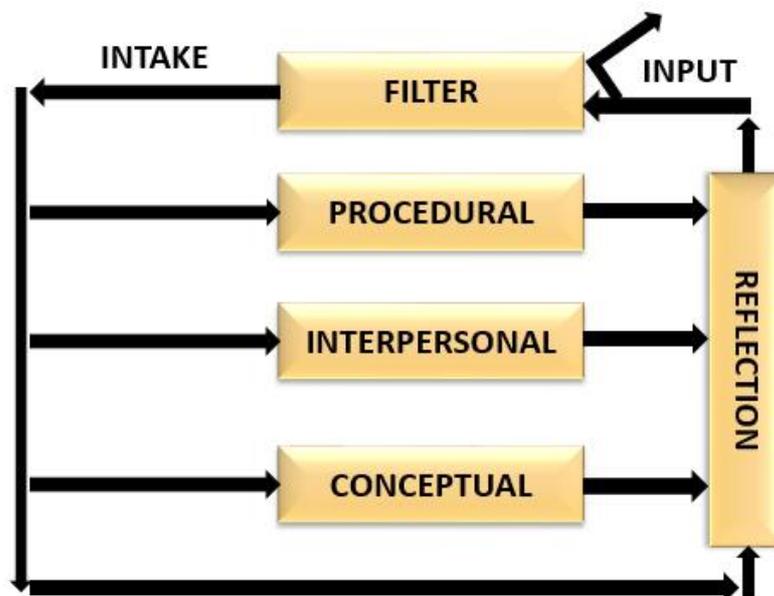


Figure 2.2: Pennington's Teacher Change Cycle (1995).

Prochaska, DiClemente and Norcross' (1992) Transtheoretical Model (TTM) of behavioural change is a multi-disciplinary approach in guiding behavioural change (Prochaska, Redding, & Evers, 2008). It describes the five stages (pre-contemplation, contemplation, preparation, action and maintenance) involved in making a meaningful change in behaviour, as well as the specific interventions or support needed at each stage (see Figure 2.3).

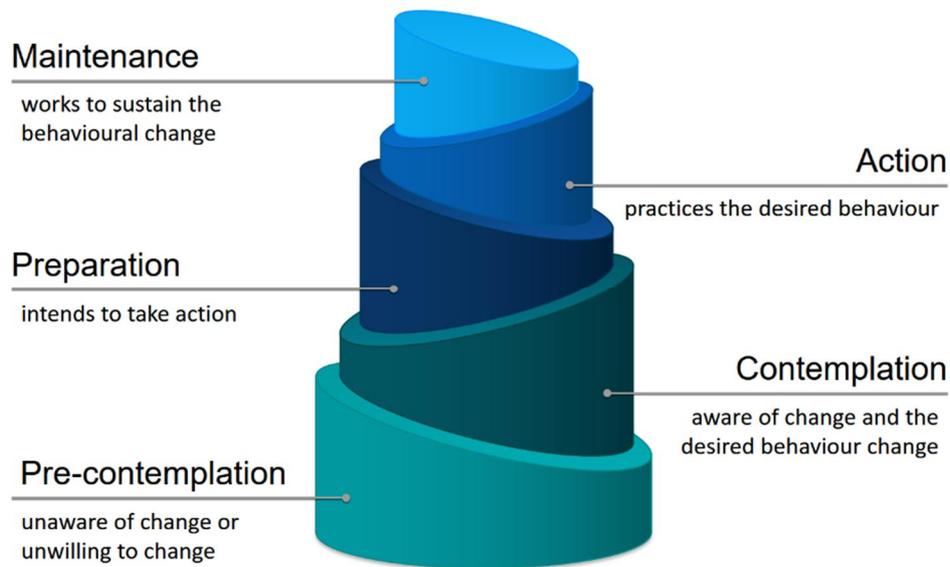


Figure 2.3: Transtheoretical Model of behavioural change stages (Prochaska et al., 1992).

The stages are not strictly linear, but more of a cyclical spiral, with up and down movement possible between the various stages (Prochaska et al., 1992). The concept of support surfaces once again within this model, as Prochaska et al. suggest that, especially during the maintenance phase, “helping relationships” is of the utmost importance (1992, p. 1011). The model was originally designed for health care professionals dealing with addiction patients. However, it is now used across disciplines and can provide a guideline for understanding at what stage different teachers may be in the change cycle.

2.5 Life-long learning

Day (1999) and Vig and Sharma (2016) claim that effective teachers are life-long learners: they not only need robust understanding of the current content they are teaching, but they also need to be able to keep up to date with the growth in new knowledge in their subjects, while adapting to the fast changes in teaching methodologies and policies. *The Minimum Requirements for Teacher Education Qualifications* (Department of Higher Education and Training, 2011) defines the seven roles, or everyday functions of South African teachers. These roles are: 1) Specialist in a phase, subject discipline or practice, 2) learning mediator, 3) interpreter and designer of learning programmes and materials, 4) leader, administrator and manager, 5) assessor, 6) community, citizenship and pastoral role and 7) scholar, researcher and life-long learner. Kanwar and Balaji (2017) argue that life-long learning is a delicate interaction between pedagogy, andragogy and heutagogy. To understand this interaction a conceptual understanding of the three concepts is needed.

2.5.1 Pedagogy

Although pedagogy is generally seen as the “art and science of teaching” (Maddalena, 2015, p. 1), the word pedagogy derives from the Greek concept *paidos* (meaning child). This infers that the focus of pedagogy is on how children learn (New World Encyclopedia, n.d.). It would therefore be more correct to define pedagogy as the art and science of teaching children (Knowles, 1980) and pedagogues as those who teach children. Teachers are therefore pedagogues, but according to Knowles, Holton and Swanson (2015), pedagogical approaches to learning do not support self-determined, life-long learning for teachers, as teachers themselves are adults.

2.5.2 Andragogy

Appova and Arbaugh (2017) conclude that there are four pillars that motivate an adult (e.g. a teacher) to learn: (i) professional learning history, (ii) educational psychological status, (iii) educational policy context and (iv) andragogy. The term andragogy stems from two Greek concepts *agogus* (leader of) and *andr-* (man) (Knowles, 1980). The term andragogy was coined by Alexander Knapp (1833), a German teacher, in an attempt to unify the methods/techniques used to teach adults under one term. The term did however not become widely used until Knowles (1970) purported that there is a conceptual difference between how adults learn and how children learn. His andragogic approach to learning defines self-determined learning as a linear process:

The process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing learning strategies, and evaluating learning outcomes (Knowles, 1970, p. 7).

Hase and Kenyon (2000) argue, and the researcher concurs, that self-determined learning is not a linear trajectory, but a process of discovery with a looping and less structured approach.

2.5.3 Heutagogy

In the 21st century society and workplace, where information is not only readily and easily accessible, but changes and grows rapidly, traditional pedagogic and andragogic methods of training cannot keep up with the demand for flexible and immediate learning approaches (Hase & Kenyon, 2000). This led to the search for a new learning approach. The Greek verb *heureskein* means ‘to discover’ and forms the root for the term heutagogy

(Parslow, 2010) that was created by Hase and Kenyon (2000) to describe the study of self-determined or self-directed learning. Heutagogy is seen as a grounding theory for guiding ICT integrated distance education programmes, particularly where social media are incorporated as an instructional delivery tool (Blaschke, 2012).

Kanwar and Balaji (2017) and Blaschke (2012) describe the interaction between these three learning approaches as an overlapping progression from pedagogy to andragogy to heutagogy. Kanwar and Balaji (2017) propose that, in pedagogy, the child learner is dependent on the teacher to provide the content, as well as the methods of learning. They further suggest that androgogic approaches presume that the adult learner has reached a level of independence where he/she prefers to learn only that which is perceived as a need and that which links to own experiences. Kanwar and Balaji (2017) see the overlap of andragogy with pedagogy in the need for a teacher-learner relationship where the teacher is still in control of the offered content. With the heutagogic approach, the learner is seen to be independent of a teacher-learner relationship and self-determines the content, method and time of learning. Blaschke (2012) describes the interaction between the three learning approaches as a progression in autonomy and maturity, and the essence of life-long learning. As one of the roles of a teacher is as life-long learner, teachers need access to TPL short courses and organisational support systems where they can assist each other to not only access, but to learn from new information as it is produced. This form of learning takes place at the intersection of the andragogic and heutagogic approaches.

2.6 A paradigm shift: From theory-laden, abstract professional development to practice-based professional learning

As the need for TPL courses was presented in the previous sections, the format of TPL courses should be addressed. Every year large quantities of money are spent globally in an effort to specifically deliver and improve teacher professional development (TPD) practices and outcomes (Borko, 2004; European Union, 2010; The New Teacher Project, 2015; Webster-Wright, 2009). In the 2012/13 financial year alone, the South African Department of Basic Education (DBE) spent nearly R60 million and the Provincial Education Departments a total of R454 million on TPD for 6.7% of the total number of South African teachers (Abdollah, Carter, & Barberton, 2013). Studies have shown that this type of expenditure on TPD have been unsuccessful in bringing about significant changes in the attitude, as well as the content and pedagogical knowledge of teachers (Mkhwanazi, 2014; Ono & Ferreira, 2010; Steyn, 2011). Some of the main points of criticism levelled against national and international TPD programmes are that they are too abstract, out-of-context

and theory-laden (Steyn, 2011; Villegas-Reimers, 2003; Webster-Wright, 2009). Ball and Cohen (1999) and Guskey (2014) suggest that TPD programmes should move away from the preparing-to-practice training model to a learning-in-and-from-practice model. This can also be called a practice-based teacher professional learning (TPL) model (Webster-Wright, 2009). Knapp (2003) renders a clear differentiation between TPD and TPL. He states that TPD refers to activities aimed at physically changing teacher practices. TPL signifies the internal cognitive change processes of teachers, implying reflection and new knowledge building that spill over into thoughtful new practices. This definition of TPL reverberates in Adler and Sfard's (2016) notion that teacher learning is a situated process where increased participation in actual teaching leads to increased knowledge in, and about, teaching. This definition also echoes in Mkhwanzi's (2014) report that effective TPL short courses are contextually relevant, practice-based and elicit changes, not only in teachers' practices, but also in teachers' attitude and cognitive investment in teaching. Corradi, Gherardi and Verzelloni (2008) expanded this practice-based learning definition by adding reflection, i.e. observing, discussion and changed acting, to the mix. Corradi et al. (2008) propose that shared reflective discussion of teacher practice adds to critical thinking and knowledge building.

Practice-based learning bridges the gap between theoretical and practical knowledge building in a kind of pendulum relationship. In this relationship, theories frame teachers' understanding of the context of an activity, whilst being aware of how the social processes imbedded in a contextual activity influence theory formation (Raelin, 2008). Practice-based learning also resonates with the quote of the social theorist, Schatzki (2001, p. 11): "In social theory ... the social is a field of embodied, materially interwoven practices centrally organized around shared practical understandings". In line with this paradigm shift from theory-laden, abstract TPD to practice-based TPL, all SUNCEP TPL courses follow a practice-based model.

2.7 Zooming in: From general Pedagogical Content Knowledge (PCK) to a focus on Topic Specific PCK (TSPCK)

A practice-based format of TPL courses describes the theory-practice balance. It does not prescribe the content that should shape the course. Shulman, the father of the concept of PCK, describes teaching as the act of teachers transforming comprehended ideas to ensure their comprehension by learners (Shulman, 1987). According to Shulman (1987) the key difference between content specialists and their teaching peers lies at the juncture of content and pedagogy - teachers show the capacity to transform their own content knowledge into

pedagogically robust formats, adapted to their learners' varying contextual and cognitive needs and abilities.

Various scholars have attempted to define PCK and its components (e.g Cochran, King, & DeRuiter, 1991; Gess-Newsome, 1999; Henze, van Driel, & Verloop, 2008; Loughran, Berry, & Mulhall, 2012; Magnusson, Krajcik, & Borko, 1999). When comparing the different definitions of PCK, the researcher has to agree with Loughran et al. (2012) that, in an effort to refine and/or redefine PCK into a more concrete, workable concept, the opposite effect seemed to have been achieved. Whereas Shulman's (1986) conceptual description of PCK seems to be "too abstract to be practical" (Loughran, Berry, & Mulhall, 2012, p. *x*), the various definitions of PCK did not improve its usability to determine "specialist or expert knowledge of practice". There is however a general consensus that, in effective TPL short courses, the focus must be on developing teachers' PCK (Henze et al., 2008; Magnusson et al., 1999; Mavhunga & Rollnick, 2013).

In an effort to compile taxonomies of PCK, Veal and MaKinster (1999) propose the term topic specific PCK (TSPCK) to accommodate differences in teachers' paradigmatic lenses on similar topics in different subjects. This same train of thought is found in Mavhunga (2014) who suggests that PCK is unique for each topic taught and that teachers therefore need to acquire TSPCK for each topic taught. The five taxonomical attributions of TSPCK are (i) learner prior knowledge, (ii) curricular saliency, (iii) what is difficult to teach, (iv) representations and (v) conceptual teaching strategies (Rollnick & Davidowitz, 2015).

In science education a recurring component of the PCK and TSPCK definitions is teachers' understanding of their learners' conceptions, preconceptions and misconceptions of science topics, combined with possible strategies to address those misconceptions (Loughran et al., 2012; Park & Oliver, 2008; Shulman, 1986). Underpinning for this idea comes from Park and Oliver's (2008) conclusions that one of the primary factors influencing science teachers' PCK is teachers' understanding of their learners' misconceptions. Rephrased, the better science teachers understand their learners' topic misconceptions, the more effective they are in adjusting their own pedagogy and teaching methodologies to facilitate learning (Rollnick & Mavhunga, 2014; Sadler, Sonnert, Coyle, Cook-Smith, & Miller, 2013). In all SUNCEP's Science TPL short courses a focus on understanding topical misconceptions forms a central part of the conceptual development activities. This focus should therefore also be included in any design of the content of a TPL support model.

2.8 Making connections: What is the connection between TSPCK and the nature of science (NOS)?

This study's subject focus is Natural and Life Sciences, which brings the concept of the nature of science (NOS) into play. Joseph Schwab, on whom Shulman drew when conceptualising PCK, contended that scientific knowledge is inseparable from the context of inquiry in which the knowledge originated (Schwab, 1982; Van Dijk, 2014). The NOS is therefore inextricably connected, and dependent on scientific content. This consequently implies that, in developing TSPCK, teachers need to acquire the ability to “teach science in the context of the inquiry in which it was developed” (Van Dijk, 2014, p. 399). This intertwined link between science teachers' understanding of NOS and applying inquiry-based teaching in their classrooms, has been around for more than 50 years. Rutherford (1964) argues that science teachers will only be able to teach science as inquiry, if they are thoroughly grounded in NOS. Another alternative coupling of these two concepts in the literature proposes that lecturers of science teachers can, through the use of inquiry-based education, assist in the development of their students' understanding of NOS (Barufaldi, Bethel, & Lamb, 1977). Consequently, the central focus of science teachers' professional learning globally is the development of informed conceptions of NOS, mainly through exposing teachers to inquiry-based learning environments that mimic authentic scientific practice (Abd-El-Khalick, 2013; Waight & Abd-El-Khalick, 2011). NOS, just like PCK, has varying definitions and needs clarification within the context of this study.

2.8.1 What is Nature of Science within an educational context?

Although the term “nature of science” has been used in research within science education since the start of the 20th century (Kimball, 1967; Schwab, 1949; Thomson, 1912), Peters & Kitsantas (2010) found that an initial consensus on the scope of the term only emerged since the middle of the 1990's (Abd-El-Khalick, Bell, & Lederman, 1998; McComas, Clough, & Almazroa, 1998). This “consensus view” highlights seven aspects or tenets of NOS: (i) Tentativeness of Scientific Knowledge, (ii) Observations and Inferences, (iii) Subjectivity and Objectivity in Science, (iv) Creativity and Rationality, (v) Social and Cultural Embeddedness in Science, (vi) Scientific Theories and Laws and (vii) Scientific Methods (Dagher & Erduran, 2016; Peters & Kitsantas, 2010).

The consensus view of NOS is however not without its debated points. Lederman (2007) is of the opinion that, although NOS and scientific inquiry are interconnected, teachers should still differentiate between the two in their teaching. This view is supported by Abd-El-Khalick

(2013) who differentiates between teaching “using inquiry-based learning” and “content only teaching” by referring to the first as teaching with NOS and the second as teaching about NOS. Both Lederman (2007) and Abd-El-Khalick (2013) base their arguments on the premise that “inquiry” refers to the procedures and methods of science, whereas NOS focusses on the philosophical or theoretical features of scientific knowledge. The researcher, however, concurs with Van Dijk (2011) who refutes this notion, posing that, to understand the products of science (NOS knowledge) the learner needs to know which inquiry process (NOS process) was used to develop the product. Van Dijk (2014) suggests that the consensus view is defined too narrowly. As an example, when referring to statement (i) of the consensus view (the tentativeness of scientific knowledge), Van Dijk (2014) points out that this statement does not explain why some scientific knowledge can be more reliable, or less reliable, than others. This inherently impedes teachers and learners from critically engaging with scientific discourses. SUNCEP's sciences TPL short courses attempt to expose teachers to the integrated nature of NOS knowledge and the NOS process. Any model of TPL short course support should thus reinforce this integrative approach.

2.9 A platform shift

Teaching and learning in the 21st century moved from a predominantly f-2-f environment to a blended, and even fully online, ICT environment. Teacher education, and especially TPL courses, should therefore model and include educational aspects of ICT.

2.9.1 Unpacking 21st century teaching skills

The 21st century brought its own set of challenges for the teaching profession. With the advent of technological advances such as television, computers, cellular phones, internet and social media in the work place, the 21st century learner should be educated and empowered to become a 21st century worker (Hanekom, 2017). Twentieth-century skills are those skills that learners need to develop in becoming productive citizens in the information age, thereby avoiding the digital gap that will exclude them from society's basic services (Ainley, Fraillon, Schulz, & Gebhardt, 2016; Kaarakainen, Kivinen, & Vainio, 2017). Various different frameworks exist that describe which 21st century skills learners need to acquire (Dede, 2010a). Examples are the Partnership for 21st Century Skills (2008), the Metiri Group and NCREL (2003), *UNESCO's ICT Transforming education: A regional guide* (Anderson, 2010), the *International Society for Technology in Education (ISTE) student standards for*

technology in the curriculum (2016) and the United States' Association of College and Research Libraries (ACRL) (2000).

The following discussion is an attempt to briefly highlight the recurring trends in the different frameworks. In the pre-21st century classroom, teacher and learner choice was unheard of. Teachers and learners rigidly conformed to a set of facts, texts and products that learners had to produce. In the 21st century classroom, ICT tools allow teachers and learners the freedom of choice to investigate facts using multi-modal, globally produced texts. It allows them to create innovative and interactive products collaboratively with learners across the globe, anytime and anywhere (Anderson, 2010; Hanekom, 2017). According to the United States' ACRL (2000), digitally literate learners can critically evaluate information, as well as the sources of that information, incorporating a selection of that information in their knowledge base, products of learning and value systems. The ISTE (2016) refers to learners who can effectively follow this incorporation process as knowledge constructors.

Cohen, Renken and Calandra (2017) conducted a survey among STEM-ICT professionals to determine which skills they deemed most valued and most frequently used in their environments. The results highlighted problem solving, critical thinking and communication skills. Some 21st century skills are perennial capabilities, but their importance is now substantially higher in the digital workplace compared to the pre-industrial workplace. These skills include collaboration, innovation and creativity, civic engagement and financial literacy (Dede, 2010b). Besides being content-masters of their subjects, 21st century teachers need to be choice leaders, critical thinkers, problem solvers, good communicators and good collaborators. To be able to instill these skills in their learners they also need to be flexible and adaptable, information and technology literate, innovative and creative, civically engaged and financially literate.

The *European Framework for the Digital Competence of Educators: DigCompEdu* (Redecker, 2017) divides the competencies needed by 21st century teachers into three types: Educators' professional competencies, educators' pedagogic competencies and learners' competencies. Educator professional competencies refer to teachers using technologies in their professional capacity, in other words for communication, collaboration, reflective practice and professional learning. Educators' pedagogic competencies are divided into four areas: use of digital resources, managing and teaching for learning with technologies, assessing using digital technologies and strategies, and using digital technologies to empower learners through inclusion and personalisation. The last type,

learners' competencies, refers to teachers enabling learners to use digital technologies creatively and responsibly (Figure 2.4).

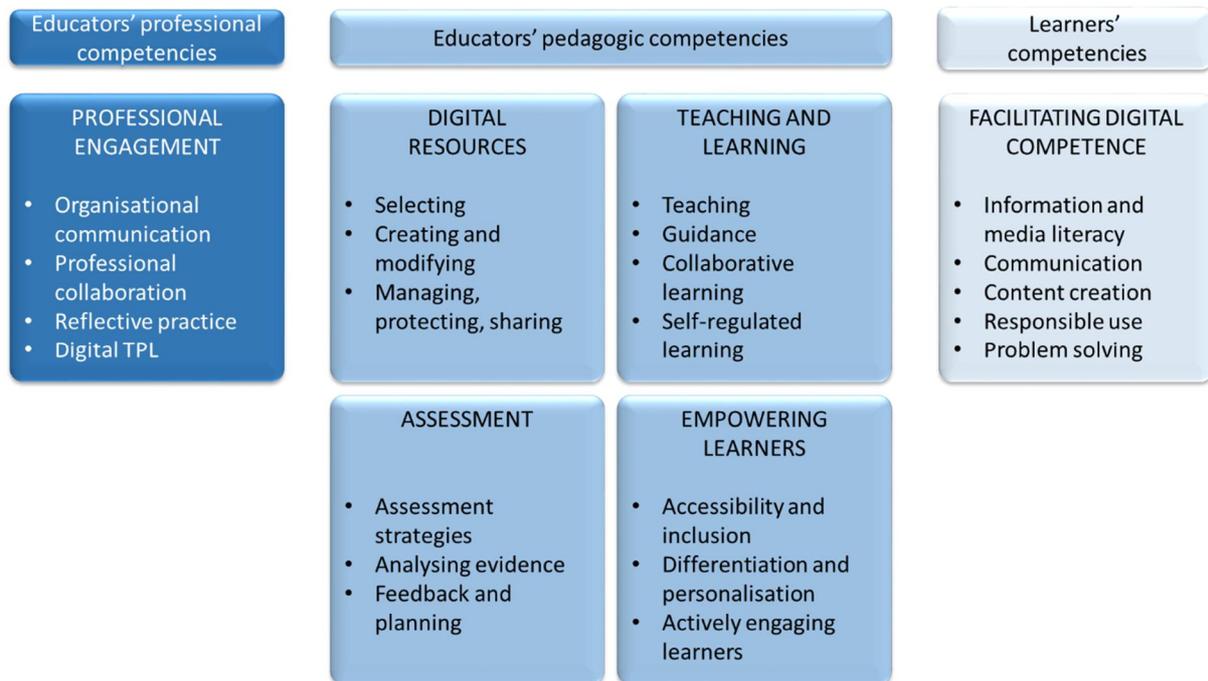


Figure 2.4: The DigCompEdu Framework. Adapted from (Redecker, 2017).

2.9.2 A definition shift: From blended-learning to ICT integrated learning

The term Blended Learning originated in the late 1980s to describe a combination of workplace-based and campus-based learning within the context of courses offered by the UK Open University (Sharpe, Benfield, Roberts, & Francis, 2006, p. 29). Another opinion is that blended-learning is the result of an ongoing process where two classic learning models, namely the face-to-face classroom environment and the distance learning environment, are starting to overlap and integrate (Bonk & Graham, 2006). As for a single, unified definition, the researcher concurs with Sharpe, Benfield, Roberts and Francis (2006) that it is impossible to create a definition that embraces all the possibilities of blended-learning. They propose eight dimensions whereby a course could be considered as being blended:

- delivery different modes (face-to-face and distance education)
 - technology mixtures of (web-based) technologies
 - chronology synchronous and asynchronous interventions
 - locus practice-based vs. classroom-based learning
 - roles multi-disciplinary or professional groupings
 - pedagogy different pedagogical approaches
 - focus acknowledging different aims
 - direction instructor-directed vs. autonomous or learner-directed learning
- (Sharpe et al., 2006, p. 18)

Although only one dimension specifically focusses on technology, this does not exclude the use of technology within the other dimensions. Picciano (2007) created a diagrammatic model, the multimodal conceptual blended-learning model, that illustrates how the different dimensions interact (Figure 2.5).

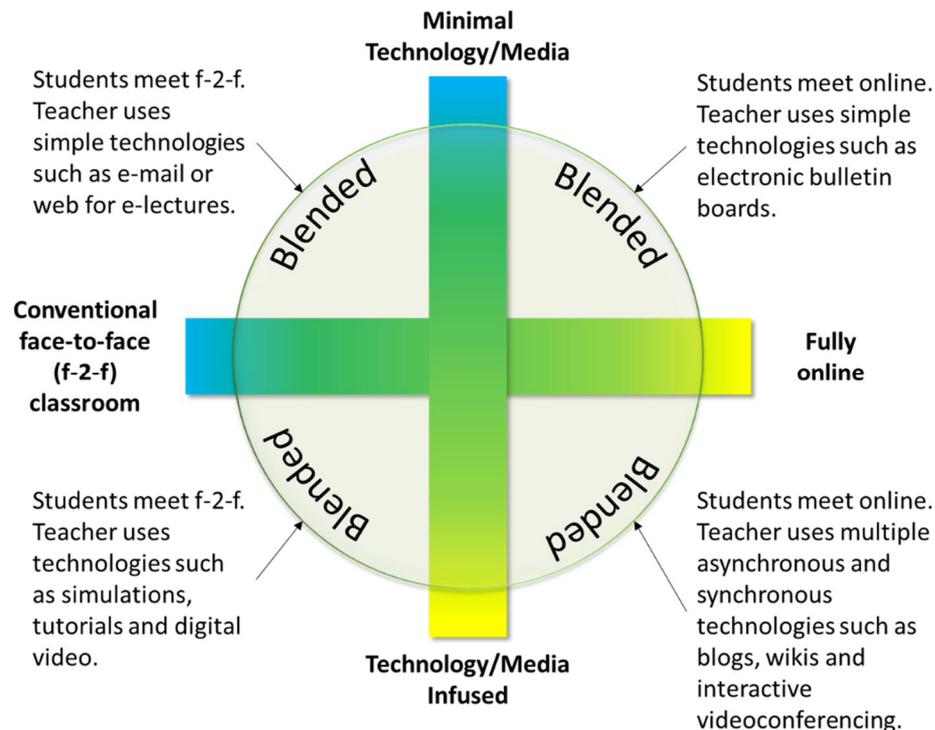


Figure 2.5: The researcher's adaptation of Picciano's (2009) multimodal, conceptual blended-learning model.

Blended-learning was initially reserved for distance learning settings in order to provide content and communication support to off-campus students. As the use of ICTs in everyday life became more common, and more possibilities for using digital tools for effective learning became available, campus lecturers began blending ICTs into face-to-face classroom environments (Norberg, 2017). Although this, per definition, is still blended-learning, a new term, ICT integration, emerged to describe the classroom synergy between ICT and non-ICT resources in a pedagogically sound way.

The 2004 *South African e-Education policy* proposes that ICT will improve schools' level of functioning, change teachers' teaching practice and improve students' learning. Vandeyar (2015) rightly doubts this assumption that a mixture of policy and ICT resources will eventually lead to changes in teacher practice and innovative pedagogical practices. In South Africa, where many schools are still under-resourced, even those schools with access to ICTs tend to focus on computer or IT skills and not on ICT integration (Nkula & Krauss,

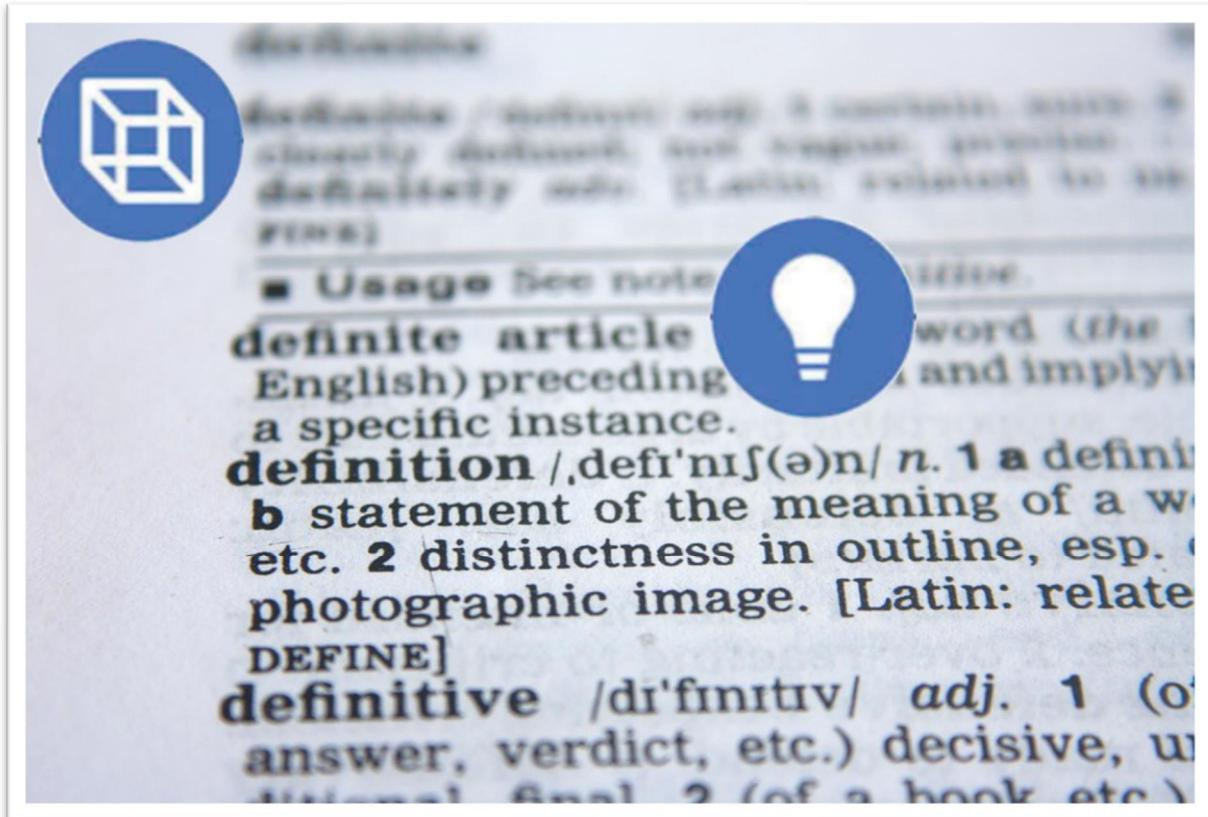
2014; Padayachee, 2017). Different barriers to ICT integration exist, but according to Nkula and Krauss (2014) the barrier most cited is a lack of teacher professional learning that focusses on, and models, ICT integration.

Cornu (1996) was one of the first teacher education researchers to comment on the need for teachers to not only be technologically skilled, but also to be trained through ICT integrated programmes. Cornu advocates for teacher professional learning programmes that model the pedagogies and methodologies that teachers should use to teach, as he posits that most teachers teach in the way they were taught. Linking to this thought, Cornu suggests that teachers need to be taught via ICT integrated courses if they are expected to integrate ICT in their teaching. This stance still holds true today, more than two decades later, and are often repeated in discourses about the level of ICT integration in schools and how TPL programmes do not address this issue (Koehler & Mishra, 2005; Koh, Chai, & Lim, 2017; Sang, Valcke, Braak, & Tondeur, 2010; Tondeur, van Braak, Siddiq, & Scherer, 2016).

2.10 Summary

Topics that influenced this study's research process were presented in this chapter. After a brief look at the complexities of the history of South African teacher education, the need for Natural and Life Sciences in-service TPL short courses (aligned to South African policies) were highlighted. This was followed by another challenge faced by South African teachers, namely the shifting landscape of policies and scope of Natural and Life Sciences teaching. Both of these challenges highlighted the need for Natural and Life Sciences in-service TPL short courses. A review of teacher change models and life-long learning discourses identified the need for organisational support of TPL short courses. A recent paradigm shift from theory-laden, abstract professional development to practice-based professional learning TPL short courses was then addressed. This led to a discussion on the conceptual shift in the content of TPL short courses from a focus on general PCK to the more specialised focus of TSPCK. TSPCK was then linked to the NOS in educational contexts. It was also linked to the need to support TPL short courses through supporting the integration of NOS knowledge and the NOS process. This was followed by a discussion on the TPL presentation platform shift from face-2-face to ICT environments. Included in the discussion was an unpacking of 21st century teaching skills. The difference between blended-learning and ICT integration was explained. This discussion highlighted the need for TPL short courses that are ICT integrated and that model ICT integration to teachers.

In the next chapter, in line with step 3 (*define* goals) of Easterday et al.'s (2017) seven-step DBR process, the theoretical framework grounding this study will be discussed. This builds up to step 4 (*conceive* the outline of a solution), represented by the conceptual framework.



DEFINE & CONCEIVE



CHAPTER 3: WEAVING A THEORETICAL FRAMEWORK TO GUIDE A CONCEPTUAL DESIGN

*“Einstein's Three Rules of Work:
1) Out of clutter find simplicity;
2) From discord find harmony;
3) In the middle of difficulty lies opportunity.”
(Wheeler, 1979)*

3.1 Introduction

Continuing with the Easterday et al.'s (2017) proposed seven-step iterative process for Design-Based Research (DBR), the study aims to *define* (step 3) the goals of the study within a theoretical framework to inform the creation (*conceive* - step 4) of a conceptual framework in this chapter. A theoretical framework forms both the support structure for a research study and the lens through which the study is viewed. In DBR the theoretical framework guides the conceptual framework, as well as the design pathway of the study. The theoretical framework elements that guided the conceptual framework are discussed, followed by discussions of the notions of teacher practice and learning theories. A discussion of indicators of effective TPL short courses and effective online support of blended model TPL short courses follows. VCoPs as support structures in TPL short courses are discussed, followed by the presentation of the final conceptual framework. Figure 3.1 provides a detailed outline of this chapter.

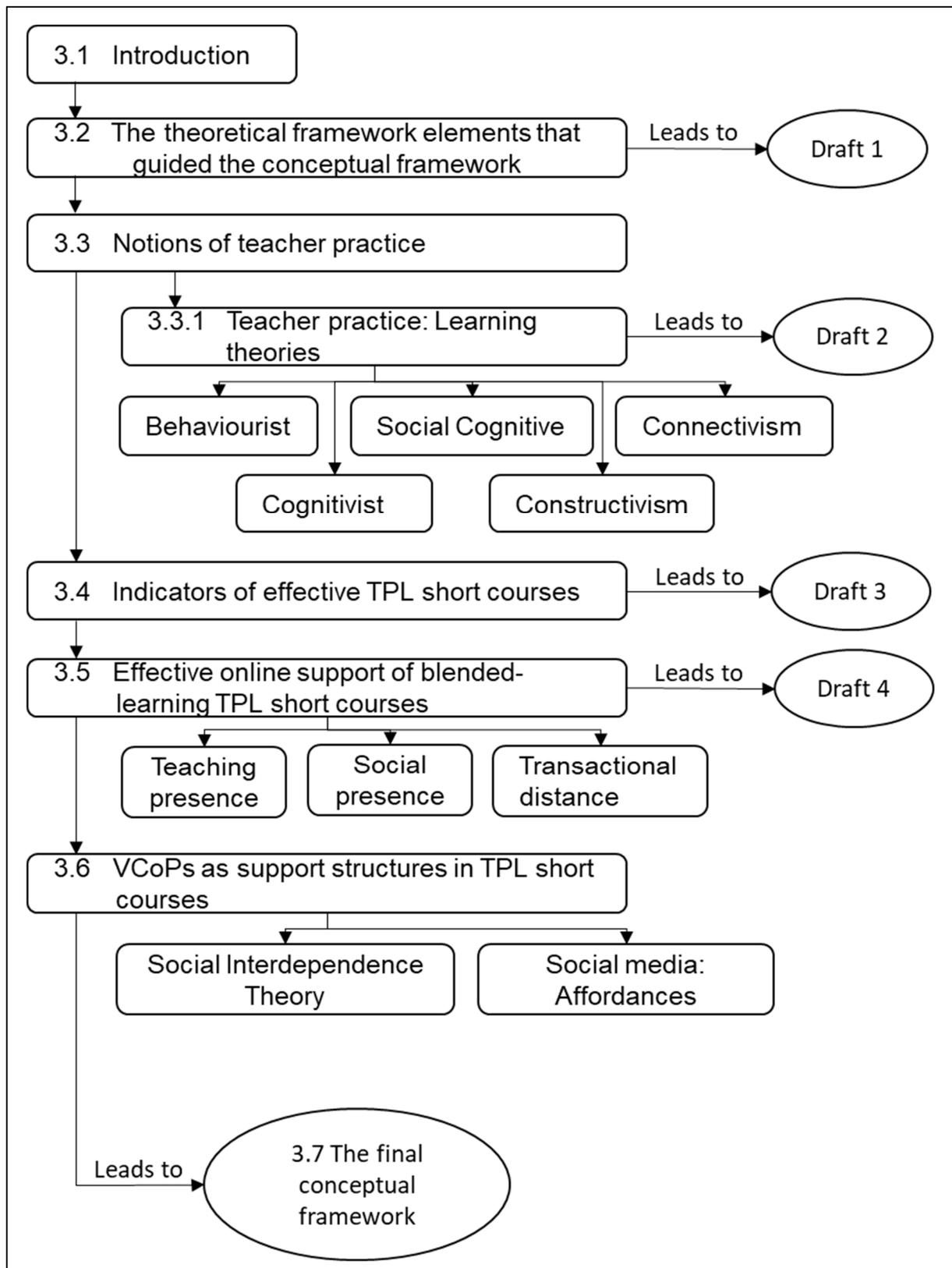


Figure 3.1: Chapter 3 outline.

3.2 The theoretical framework elements that guided the conceptual framework

In Chapter 2 (review of the literature) the need for support of teachers during TPL short courses, as well as the need for ICT integrated programmes, were highlighted. The design of an effective support model for TPL short course programmes by means of virtual CoPs (VCoPs) is guided by a theoretical framework that leads to a conceptual framework. Having the conceptual framework as end-goal for this chapter, the researcher created a visual representation of a first draft conceptual framework, with questions that could inform her as to which theories should form part of the theoretical framework (Figure 3.2). The four main questions that guided the creation of the conceptual framework were:

1. Which learning theories underpin the support needs of teachers during TPL short courses?
2. Which theories underpin the indicators of an effective TPL short course?
3. Which theories underpin effective online support?
4. Which theories underpin the use of virtual PLCs as support structures in TPL programmes?

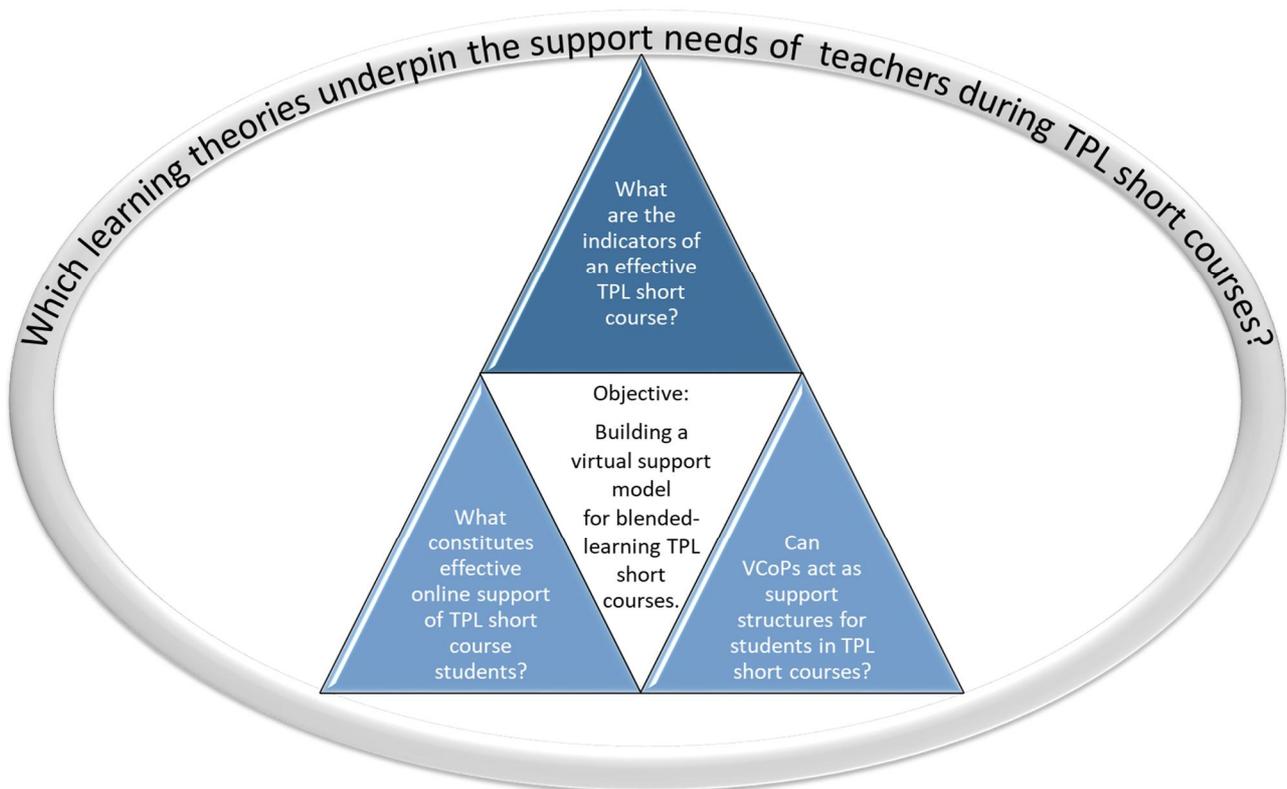


Figure 3.2: The first draft version of the conceptual framework.

In the following sections the different questions are addressed to inform the theoretical framework and to ultimately create the conceptual framework.

3.3 The need for support of teachers during TPL short courses - notions of teacher practice

Historically learning was seen as an individual process, where being present in a learning environment should lead to the development of knowledge and insight within the learner (Johnson & Johnson, 2002). Johnson and Johnson (2002, p. 119) remarks on how the teaching profession is probably the only profession where a time traveller from the 15th century would, in most classrooms, still feel at home: “The same assumptions continue that teaching is telling, learning is absorbing what the teacher tells, and knowledge is subject matter content”. Hussin (2018), however, proposes that the 4th Industrial Revolution (4IR) wave is steadily infiltrating classrooms. The rapid evolving of technology because of 4IR means that teacher education institutions have not been able to keep up with preparing pre- and in-service teachers for changes in tools, skills and pedagogies, and the concurrent expectation of development of 21st century skills in learners (Hussin, 2018). Johnson and Johnson (2002) also suggest that, although there has been theoretical advances in the paradigmatic shift from teacher-centred individual learning to learner-centred social learning, classroom reform has been slow to follow suit. Learner-centredness requires a change in role for both the learner and the teacher, and not only a change in the type of learner activities (Antón, 1999; Harley, Barasa, Bertram, Mattson, & Pillay, 2000; Schweisfurth, 2015). Antón (1999) and Harley et al. (2000) see the role of the learner-centered educator as guiding learning activities and procedures, while establishing situations likely to promote social inquiry and collaborative knowledge building. The educator becomes a supporter of knowledge building, in contrast to the holder and provider of all knowledge (Antón, 1999; Johnson & Johnson, 2002). Schweisfurth (2015) argues for the importance of teacher re-education, as the pedagogy of learner-centeredness differs so drastically from that of the traditional teacher-centred approach. This impacts the teacher education and development domain, where a slow shift from theory-laden, abstract professional development to socially situated, practice-based professional learning can be seen (Adler & Sfard, 2016; Corradi et al., 2008; Knapp, 2003; Webster-Wright, 2009).

3.3.1 A learning theory view of teacher practice

Teaching, and therefore TPL short courses, should however not only reflect and follow current notions of teacher practice, but they should be aligned to a learning theory that directs teaching practice. There are various learning theories, but the four that will be focussed on in this discussion are the behaviourist, cognitivist, constructivist and connectivist learning theories.

3.3.1.1 Behaviourist learning theory

The behaviourist learning theory was established in 1912 by John B Watson (1878 -1958). It was developed in an attempt to turn the, up until that point, subjective field of psychology into an objective and experimental division of the natural sciences (Watson, 1913, 1925). Behaviourists claim that consciousness, the usual landscape of psychology, cannot be defined and that only behaviour can be understood and modified, as it can be experimentally observed (Watson, 1925). Behaviourists therefore define learning as an act of changing human behaviour and argue that the most elementary component of learning is practice and reinforcement strategies, e.g. rote-repetition. This links to a fully teacher-centred approach (Watson, 1925). Another drawback of the behaviourist learning theory is that it does not offer adequate explanations for how higher-order thinking skills, such as problem solving and critical thinking, develop in humans (Ertmer & Newby, 2013). The behaviourist theory leaves very little room for the Deweyan Pragmatist view that learning is a social construct. Despite these conceptual problems with behaviourism, Ertmer and Newby (2013) report that, not only is behaviourism still the hallmark of most classroom teaching practices, but it even pervades the online instruction context.

3.3.1.2 Cognitivist learning theory

By the 1960s cognitive learning theory replaced behavioural learning theory as the main learning theory in education (David, 2015). In contrast to the behaviourists, the cognitivists argue that inner mental activities, such as consciousness and learning, can and should be studied, focussing specifically on the higher-order information-processing skills (Ertmer & Newby, 2013). Bower and Hilgard (1981) place cognitive learning theory in the more rationalist area of the epistemology spectrum. Learning is described as discrete changes in knowledge acquisition stages, namely information input, organisation, storage and retrieval (Ertmer & Newby, 2013). Bandura (1971) extended the cognitive learning theory to include the social nature of learning, becoming the father of the social cognitive learning theory.

3.3.1.3 Social Cognitive Learning Theory

Bandura postulated that students learn within a social context, learning from one another through observing, imitating, modelling and self-reflectiveness (1971, 2001). Bandura (2001) posits that people are not only the products of a social system, but they are also the producers of that system. According to Bandura (2001) a social system, like a TPL short course with its instructors and students, would therefore not be a static entity, but an ever-

changing, socially coordinated and interdependent system. In a blended model of presentation, where a disconnect can easily occur between educator and student relationship, thereby affecting the ability for a learning community to form (Reese, 2013), social cognitive theory would suggest a system of support that could prevent dissociation of the social system. Cognitive learning theories offer a plausible explanation for higher-order learning development, with social cognitive theory in particular offering a social component to how learning takes place. In essence though, cognitive learning theory still strives for the same end goal in an educational context, i.e. to find the most effective and efficient way to transfer knowledge from the teacher to the student. It is therefore, in essence, still a teacher-centred approach (Bednar, Cunningham, Duffy, & Perry, 1991; Harasim, 2012).

The two main learning theories aligned to the 21st century educational context are constructivism and connectivism. To decide which of these two learning theories should be the grounding theory for TPL short courses, thereby guiding this study, a description of, and differentiation between, the two learning theories follow.

3.3.1.4 Constructivism

The root of the term constructivism is 'to construct'. It is derived from the Latin 'con struere' and denotes the actions of arranging, giving structure or organising¹⁶. Piaget (1972) viewed learning as the actions of discovery and reconstruction of knowledge by rediscovery, through the processes of assimilation and accommodation, thus restoring equilibrium in cognitively conflicting situations. This concept of actioned organisation led Jean Piaget (1972) to become one of the eminent figures in the development of the cognitivist theory of constructivism. Although Piaget is seen as the father of constructivism, it should be noted that, in 1710, an Italian philosopher and social theorist, Vico, in *De Antiquissima Italorum Sapientia Ex Linguae Latinae Originibus Eruenda* repeatedly stressed that 'to know' implies that the individual knows how to construct. Vico (1710/1988) can therefore be seen as the first to suggest constructivism (Von Glasersfeld, 1989). The constructivist epistemology has an anti-objectivist and anti-positivist view on human knowledge¹⁷. Whereas objectivists view knowledge as absolute and matching reality (Harasim, 2012), constructivists believe that knowledge can be constructed. They further believe that this construction is a human endeavour through which humans make sense of the world through development, testing

¹⁶ <http://dictionary.reverso.net/english-definition/construct>

¹⁷ CT Constructivism WBI, www.de-research.com/PhDFinalPapers/CT_ConstructivismWBI.pdf

and refining of cognitive representations (Boyle, 2000). Therefore human learning, viewed from a constructivist learning theory, entails not only growth of knowledge, but development of knowledge (Ndlovu, 2013). This view of learning clearly impacts on teaching strategies, especially as radical constructivists pose that 1) "the teacher's knowledge cannot be conveyed to the students" and 2) "the teacher's mind is inaccessible to the students, nor are students' minds accessible to the teacher" (Sierpinska & Lerman, 1996, p. 843). Ndlovu (2013) and Asamoah and Oheneba-Sakyi (2017) concur with this view in their argument that constructivist teaching is a process of leading the learner to integrate concepts that harmonise with their existing cognitive knowledge base. Even more importantly, they argue that constructivist teaching leads learners to restructure and incorporate new concepts that are disjointed with their current knowledge base. Cognitive constructivists, such as Piaget and his followers Bruner (1987), Ausubel (1968) and von Glasersfeld (1989), propose that knowledge construction is an individualised, intrapersonal process where social interaction simply acts as incentive to create cognitive dissonance (Liu & Matthews, 2005). On the other hand Vygotsky (1978), the father of social constructivism, and theorists such as Kuhn (1970), Lave and Wenger (1991) and Simon (1995) place social interaction centrally within the constructivist paradigm, suggesting that learning is socially mediated, context-bound and a situation-specific action (Liu & Matthews, 2005). Social constructivists therefore argue that learners' interactions within their learning community create both cognitive conflict and knowledge construction. The social constructivist approach in Life and Natural Sciences teaching focusses on enhancing learning through written and spoken dialogue, within collaborative or scaffolding learning environments (Barak, 2017; Lemke, 2001). This learning theory resonates with the current stance of socially situated, practice-based professional learning in the teacher-training domain, and could theoretically guide TPL short courses.

3.3.1.5 Connectivism

With the advent of the 21st century, technology infiltrated the daily lives of humans, thereby changing our previous understanding of what a social system is. Where the interactions within a social system previously suggested a physical presence of the participants, a virtual presence is now also possible. Siemens (2004, 2008), building on Downes' (2005) view of knowledge as comprising of connections and networked units, suggests connectivism as a socially grounded learning theory for technology mediated knowledge acquisition. Connectivism suggests that knowledge creation consists of a process of collecting information across different networks (physical and/or virtual) and identifying connections

and related patterns within the information (Downes, 2012). This resonates with Cronon (1998, p. 77) who states: “More than anything else, being an educated person means being able to see connections, so as to be able to make sense of the world and act within it in creative ways”.

Connectivism as learning theory is however not without its detractors. One of the main counter arguments is that connectivism too closely resembles constructivism, in that it also views learning as a social, active process taking place in a distinct context, and that it requires reflection (Flynn, Jalali, & Moreau, 2015; Kop & Hill, 2008; Mattar, 2018). Flynn, Jalali and Moreau (2015) argue that the only unique angle to connectivism is Downes' (2012) view that technology, as the holder of knowledge, mediates knowledge acquisition through the formation of connections. These connections can form between learners and the information, but they can also form between groups of learners, thereby forming communities of learning. Mattar (2018) also proposes that connectivism is not a new learning theory, but rather an upgraded version of constructivism, linking it to an expansion of Vygotsky's (1978) concept of the zone of proximal development (ZPD). Whereas Vygotsky's (1978) constructivist view of ZPD envisions a more experienced peer or teacher facilitating the learning experience, the connectivist view suggests that the ZPD can be retracted or expanded through technologically enhanced, network-directed activities (Mattar, 2018). Kop and Hill (2008) agree that connectivism has little to add to existing learning theories, as constructivism already explains the relationship between external and internal knowledge resources. Wenger's (1998) community of practice model explains the social setting of knowledge creation. According to Kop and Hill (2008) the main difference between constructivism and connectivism is on the level of how the concept of learning is defined. While constructivists view learning as learners actively constructing, deconstructing and reconstructing knowledge to form new knowledge (Piaget, 1972; Vygotsky, 1978), connectivists perceive learning as learners making connections with a network of knowledge that exists in a technological context (Downes, 2012; Siemens, 2006).

Clará and Barberá (2014) pose a different counter argument. They propose three major psychological and epistemological problems with connectivism. The first problem is a psychological conceptualisation issue, namely that connectivism, unlike the other learning theories, does not address the learning paradox described by Socrates. The learning paradox suggests that, when the learner does not have knowledge of something, the learner is incapable of looking for it, as he or she cannot recognise it. On the other hand, if the learner is able to recognise it, he or she must have some knowledge of that something.

Historically learning theories had to offer a solution to the learning paradox (Clarà & Barberà, 2014). Social constructivism, for example, attempts to address this paradox within a social interaction setting, where the new knowledge is constructed by the different learners, each contributing to, and building on, their own preconceptions, as well as from the resources that they have access to. These resources can be online resources and/or the teacher (Biesta, 2013; Hwang & Roth, 2011). The researcher also concurs with Flynn, Jalali and Moreau (2015) and Kop and Hill (2008) who do not view connectivism as a distinct learning theory, but rather a precursor to a much needed new paradigm of learning. Trnova and Trna (2017) and Mattar (2018) eloquently suggest connectivism to be a social constructivist learning theory, extended through connectivist factors. The main connectivist factor highlighted by Trnova and Trna (2017) is networking. This networking includes formal and informal virtual networks that support teachers by providing advice and assistance with their educational challenges (Trnova & Trna, 2017). Tschofen and Mackness (2012, p. 28) highlight the factors of “autonomy, connectedness, diversity and openness”. Twenty first century teacher practice, and as a consequence TPL short courses and this study, should therefore function within the lens of social constructivist learning theory, extended through connectivist factors. This lens was added to the second draft of the conceptual framework in Figure 3.3.

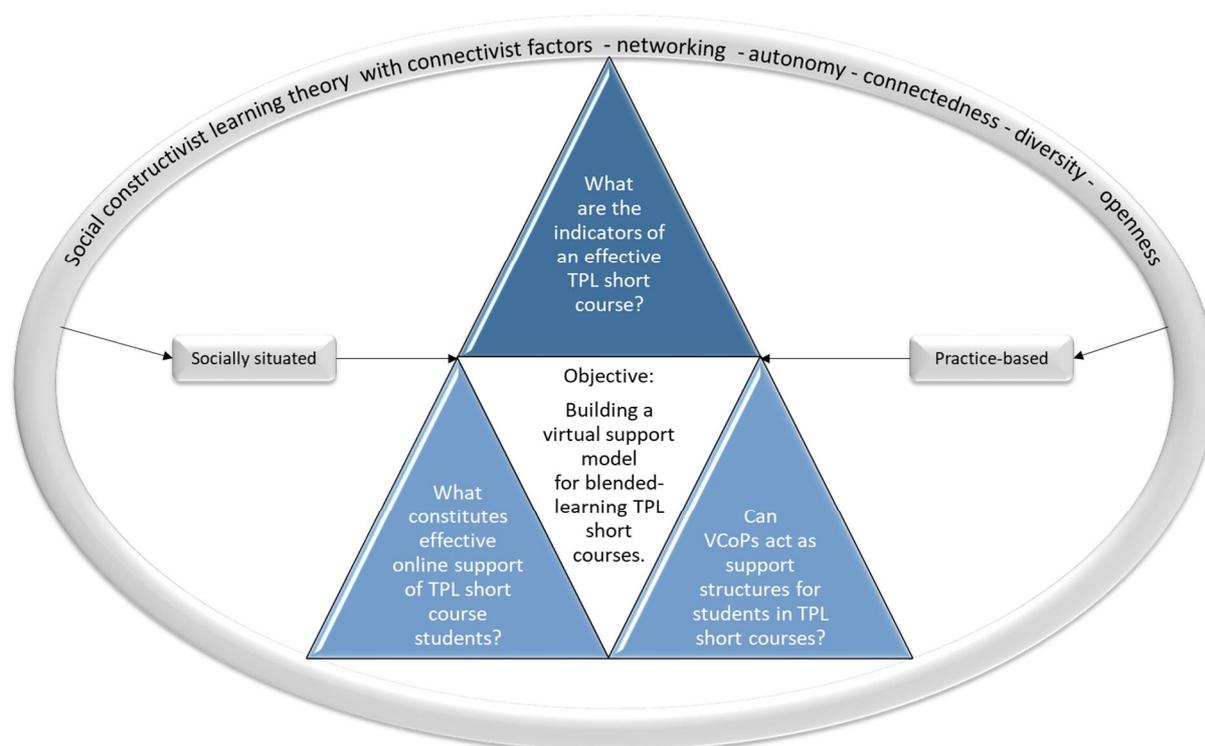


Figure 3.3: The second draft version of the conceptual framework.

Therefore, for learning to take place in a social constructivist context, TPL blended-learning short courses should provide both a practice-based environment and the required social support structure. This feeds into the objective of this study.

3.4 The indicators of effective TPL short courses

Taubman (2014) points out that teaching is different from many other professions. As an example he contrasts effective teaching with good plumbing, stating that, even when a teacher learns to use all the tools of the trade, it does not guarantee that learners in that teacher's class will learn. Taubman (2014) also contrasts teaching with medicine where anaesthetics or antibiotics work regardless of the worldview of the doctor or the patients' state of hunger. Measuring effective teaching is not an easy task, neither is measuring effective TPL. Effective TPL short courses have two main foci. The first is building teacher capacity to assist students to perform at their potential (DiPaola & Hoy, 2014; Patton, Parker, & Tannehill, 2015). The second is supporting lifelong learning, as TPL is a continuum and not a confined event (Feiman-Nemser, 2012). Different researchers, however, have different views on evaluating the effectiveness of TPL short courses. Guskey (2002) stipulates five levels for evaluating the effectiveness of a TPL short course, namely: participants' reactions (level 1), participants' learning (level 2), organisational support and change (level 3), participants' use of new knowledge and skills (level 4) and student learning outcomes (level 5). Desimone's (2009) four point conceptual framework for TPL short courses focusses on whether a) teachers experience professional learning as effective; b) TPL increases teachers' professional learning skills and knowledge and/or changes their beliefs and attitudes; c) teachers use their new knowledge and skills, attitudes and beliefs to expand their subject content knowledge or their pedagogical approaches, or both and d) the changes in teachers' pedagogy nurture increased student learning. More recently, Patton, Parker and Tannehill (2015) suggested eight core features, which they grouped into three main levels: Teacher engagement (level 1); teaching practice (level 2) and student learning (level 3). Neither Desimone (2009) nor Patton, Parker and Tannehill (2015) include a specific organisational support level. The researcher perceives this as a major deficiency. The researcher concurs with Bonaccorsi (2014) who suggests that, after Guskey's (2002) level 5 (student learning outcomes), the most important level in teacher professional learning is organisational support and change (Table 3.1).

Table 3.1:

A comparison between Guskey (2002), Desimone (2009) and Patton, Parker and Tannehill's (2015) views on evaluating the effectiveness of TPL short courses

Guskey (2002)	Desimone (2009)	Patton, Parker and Tannehill (2015) (CF = Core feature)
Level 1: Participants' reactions	1. Teachers experience professional development as effective.	Level 1: Teacher engagement <ul style="list-style-type: none"> • CF 1: Based on teachers' needs and interests • CF 2: Acknowledges that learning is a social process • CF 3: Includes collaborative opportunities within learning communities of educators • CF 4: Is ongoing and sustained
Level 2: Participants' learning <ul style="list-style-type: none"> • active learning experiences for teachers and opportunities to adapt practices to their classroom context • adapted to fit the specific context and content and/or process needs of the teachers • focus on enhancing teachers' pedagogical content knowledge • require at least 30 hours contact time 	2. Increased teachers' professional development knowledge and skills and/or changes their attitudes and beliefs <ul style="list-style-type: none"> • content: focus on content needs of teachers • coherence: with school, district and state reforms and policies. • active learning • duration: 20 hours or more of contact time • collective participation: same school or district 	Level 2: Teaching practice <ul style="list-style-type: none"> • CF 5: Treats teachers as active learners • CF 6: Enhances teachers' pedagogical skills and content knowledge • CF 7: Is facilitated with care
Level 3: Organisational support and change		
Level 4: Participants' use of new knowledge and skills	3. Teachers use their new knowledge and skills, attitudes and beliefs to improve the content of their instruction or their approach to pedagogy, or both.	
Level 5: Student learning outcomes.	4. The instructional changes in teachers foster increased student learning.	Level 3: Student learning <ul style="list-style-type: none"> • CF 8: Focuses on improving learning outcomes for students

Although Guskey's level 3 implies support via educational districts and departments, adequate organisational support is not always possible in the South African context, where educational districts either cover geographically large rural areas or school dense urban areas. As an example: one of the rural districts in the Western Cape Province in which SUNCEP offers TPL short courses has 32 schools in a 12 981 km² area. This roughly equates to one school per 418 km² on average¹⁸. It is therefore close to impossible for a single subject advisor to support and mentor all teachers effectively on site, even though he or she might be very passionate and knowledgeable about his or her subject and teachers. It is envisaged that an organisational support strategy, via virtual communities of practice on WhatsApp, could offer level 3 support to these teachers, and lighten the load of the educational districts and departments.

Although Guskey's (2002) five levels appear to be organised in increasing levels of importance, each level addresses a different aspect within the complexity of TPL and does not form a hierarchical progression. It is also not the intention of this study to attempt to address all the Guskey levels in their entirety, but rather to determine and highlight those levels that VCoP use within TPL short courses can support. There will be a specific focus on level 3, organisational support.

Each of Guskey's (2002) five levels has different key indicators of effectiveness:

Level 1: Participants' reaction. At this level the focus is on the initial satisfaction of teachers with the TPL short course they attended. Feedback on this level can inform the design and delivery of the programme. Key indicators in this level are satisfaction with the logistics, content choice and the facilitator's perceived knowledgeability and support.

Level 2: Participants' learning. This level seeks to validate the relationship between what was intended by the TPL short course and what was achieved. The key indicator is the ability of the teachers to demonstrate their newly acquired knowledge and/or skills.

Level 3: Organisational support and change. This level focusses on teacher support for every aspect of the programme, during and after contact. Guskey (2002) and Fullan (1993)

¹⁸ L. Manas, personal communication, September 20, 2017

mention that a lack in organisational support has led to the downfall of some of the finest development strategies. The key indicators are proof of, and teacher perception of, adequate support during and after contact.

Level 4: Participants' use of new knowledge and skills. Level 4 links to level 2, but extends into teachers' classrooms, striving to show implementation and application of the acquired knowledge and/or skills. The key indicator is physical proof that teachers are implementing and applying their newly acquired knowledge and/or skills in the classroom.

Level 5: Learner performance. Evidence of improved student performance is the main focus of this level. Within this study, determining short course impact on learner performance is only possible via teacher feedback and teacher perception.

The key indicators for effective TPL short courses were clearly delineated in this section and led to the third draft of the conceptual framework (Figure 3.4).

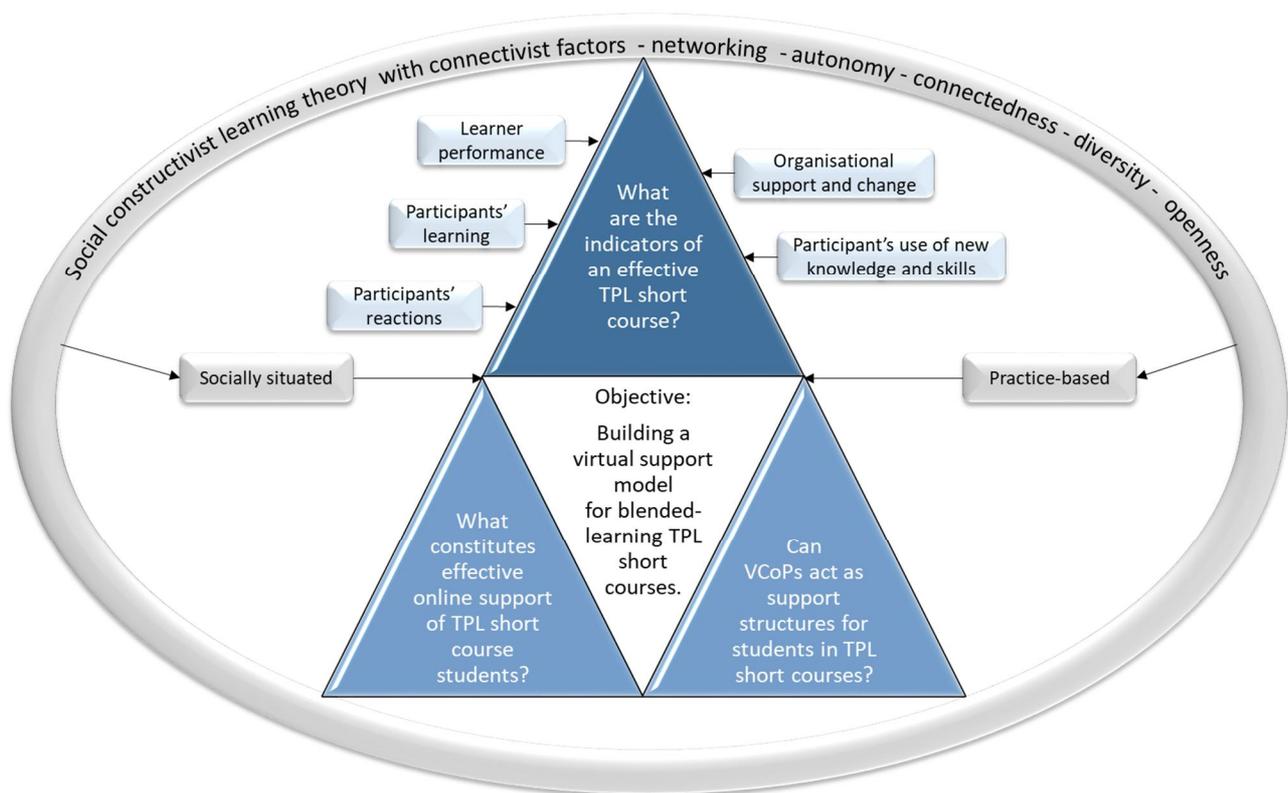


Figure 3.4: The third draft version of the conceptual framework.

The key indicators will also inform the development of the hypothetical support trajectory for TPL short courses in Chapter 4.

3.5 Effective online support of blended-learning TPL short courses

The increase in blended models of education, especially where the face-to-face components are decreasing in length, raises questions about effective student support (Hughes, 2007; Thomas, 2005). The advent of Web 2.0 and higher technologies allows for communication between facilitator and student; something that was not possible with Web 1.0 and early ICT technologies, such as video and TV (Ghamdi, Samarji, & Watt, 2016; Huffman, Albritton, & Wilmes, 2011). In blended model programmes where students are geographically separated for extended periods between physical contact time, the notions of teaching and social presence, and transactional distance, become important tenets, especially when creating virtual spaces to host both academic and social support communities (Hughes, 2007; Yorke, 2004). Ke (2010) and Sun and Chen (2016) pose that social presence, second only to teaching presence, is crucial for cognitive engagement to occur in online students, and that, especially in adult students, learning satisfaction directly correlates with how strong their sense of community is. Creating teaching and social presence (Baker, 2010; Sharples et al., 2013) and minimising transactional distance (Huang, Chandra, DePaolo, & Simmons, 2016; Murphy & Rodríguez-Manzanares, 2008) within a virtual environment are, however, not as straight forward as in face-to-face contexts.

3.5.1 Teaching presence

Garrison, Anderson and Archer (2001, 2010) developed the communities of inquiry framework to describe the dynamic interrelationships that exist between three very specific elements in online learning environments. These three elements are social presence, cognitive presence and teaching presence (Swan, Garrison, & Richardson, 2009; Wang, Han, & Yang, 2015). In educational VCoPs, both cognitive independence and social interdependence are encouraged (Ndlovu & Mostert, 2018). Teaching presence is seen by Anderson, Rourke and Garrison (2001) as a three faceted element that designs, facilitates and directs the other two elements to ensure learning outcomes that are both personally meaningful and educationally worthwhile for the participants. In an online environment such as a VCoP, the course facilitator must manage all three facets. The design facet of teaching presence refers to the design and organisation of curriculum content, learning activities and timeframes (Garrison, Cleveland-Innes, & Fung, 2010; Ndlovu & Mostert, 2018). The facilitation of discourse facet not only refers to the monitoring of conversations, but specifically to ensuring that purposeful discussions and reflections take place. The direct

instruction facet refers to purposeful interventions by the facilitator to ensure that the intended outcomes of the VCoP are reached.

3.5.2 Social presence: Immediacy and intimacy

Short, Williams and Christie (1976) describe social presence theory in face-to-face situations as the degree to which people feel connected to each other in any interaction and the resultant feeling of reality of that interpersonal relationship. They regard social presence to be the most crucial behaviour in any person-to-person communicative environment, encompassing two components: intimacy and immediacy. Both these components were previously described as separate entities in relation to face-to-face communication (Argyle & Dean, 1965; Wiener & Mehrabian, 1968), but Short et al. (1976) propose that in any person-to-person communication these two components are fundamental.

Immediacy can be defined as “the relationship between the speaker and the objects he communicates about” (Wiener & Mehrabian, 1968, p. 3) or the distance (real and/or perceived) between the teacher and the students (Gorham, 1988; Moore et al., 1996). Witt, Wheelless and Allen (2006) find a direct correlation between teacher immediacy and learner cognitive learning. The correlation exists in both a verbal and non-verbal context. Their findings are supported by Baker (2010) who reports that lecturer immediacy is directly correlated to student cognition, affective learning and motivation. In an online environment, physical immediacy has to be recreated within a virtual context for both student and lecturer. One obstacle to immediacy within an online environment occurs when students do not post, but only read within the environment, thereby appearing to be absent, as they do not have a bodily presence in that online environment. Using Schatzki’s (2002) terminology, the students’ intentionality collides with the limitations of the artefact. Bolldén (2014) cautions against the assumption that students are deemed absent when they do not have a bodily presence at a given time. She likens this to the face-to-face situation where bodily presence does not guarantee cognitive presence. Such seemingly absent students in the online environment make up the majority of individuals (Crawford, 2009) and have been named lurkers (Nonnecke & Preece, 2000). Nonnecke and Preece go so far as to suggest that up to 90% of individuals in virtual groups are lurkers. When the term was coined it had a negative connotation, suggesting that lurkers were individuals who did not contribute to the online environment and who had to be encouraged to become active participants (Bishop, 2007; Nonnecke & Preece, 2000). However, Crawford (2009) suggests that these

individuals should rather be referred to as listeners, dividing them up into background listeners, reciprocal listeners and delegated listeners. Crawford argues that lurkers in online community settings, such as WhatsApp or Twitter, could be tracking the posts of others and she concurs with Lee, Chen and Jiang (2006) and Rimé (2017) that, in any social context, on- or offline, the supposed inactive participation of listeners do not detract from the overall functioning of that community. In this study the listeners' perceived on-line inaction were also probed to understand whether their perceived inaction influenced their perception of WhatsApp groups as support systems.

Argyle and Dean (1965) suggest that intimacy consists of an awareness of non-verbal behaviours, such as smiling, eye contact and the proximity of human bodies between participants in a conversation. In more recent studies the dual concepts of intimacy and immediacy have been encapsulated as a dual nature of immediacy, consisting of verbal and non-verbal immediacy behaviours (Biocca, Harms, & Burgoon, 2003; Ghamdi et al., 2016; McLaughlin, 2013). The concept of embodiment has been added for a richer description of social presence (Bolldén, 2014; Ghamdi et al., 2016).

3.5.3 Social presence: Embodiment

At the core of theories about embodiment is the notion that certain human bodily systems, especially those that handle action, perception and emotion, developed specifically, and in specific ways, to support and enhance higher cognitive processes (Glenberg, 2008). Although there is considerable interdisciplinary variation in the concept of embodiment, the notion that the mind is influenced by what the body experiences is central to both the social- and neurosciences (Farr, Price, & Jewitt, 2012). In an online environment, where the physical body and visual cues regarding perceptions and emotions are scarce or absent, both the lecturer and students need to find other ways to embody themselves. Farr, Price and Jewitt (2012) suggest that human speech often conveys how bodily experiences influence cognition. One example would be the metaphor “she’s a square peg”, which takes the physical idea of two parts not fitting together into the cognitive space of socially not fitting in (Lakoff, Espenson, Goldberg, & Schwartz, 1991). In a virtual environment text often replaces speech, and Bolldén (2014) uses the example of lecturers literally typing themselves into being. Embodiment via speech in an online environment is, however, still possible through, for example, voice notes in WhatsApp. Lecturers can also use video clips as a form of embodiment by either creating video clips or using pre-created video clips (e.g.

YouTube videos). Biocca, Harms and Burgoon (2003, p. 485), when speaking about the notion of a virtual presence, refer to it as a “sensory awareness of the embodied other”. In other words, although a physical body may not be present in the virtual space, the participants are aware of the co-presence of each other through their senses. The usual face-to-face, non-verbal immediacy behaviours that contribute to the sensory awareness of embodiment, such as eye contact, body language and emotions, are however much harder to replicate in a virtual context (Ghamdi et al., 2016; Lee & Mcloughlin, 2011). Ghamdi et al (2016) first used the term e-immediacy for those immediacy behaviours that can be found in a virtual learning environment. They also list a collection of these e-immediacy behaviours, highlighting examples of verbal e-immediacy behaviours, such as initiating discussion through storytelling, asking questions to elicit responses, using humour through funny stories or photo’s, using self-disclosure by linking an event the lecturer experienced to the content, addressing students by name and using inclusive pronouns, such as you, your and we. As for non-verbal immediacy behaviours, they suggest emoji’s and text formatting (Table 3.2):

Table 3.2:
*Online lecturer/teacher immediacy (Ghamdi et al., 2016, p. 18).*¹⁹

N	Non-verbal e-immediacy behaviours	Examples
1	Smiling	
2	Monotone voice	<i>Italics</i> or CAPITAL LETTERS
3	Vocal expressions	CAPITAL LETTERS
4	Gestures	
5	Vocalisation	Interjections in online discourses
6	Animated moves	

WhatsApp, as a form of web 2.0 application, adds to the mixture of e-immediacy behaviours through the options of voice notes, that add speech and vocal expressions, and video clips, that can show the human body in motion. Both the students and facilitators in the pilot study used text, emoticons, voice notes, photos and videos of themselves in action in their

¹⁹ Used with permission from authors.

classrooms, to embody themselves in the virtual environment of the studied WhatsApp support group.

Social constructivism speaks to all three modalities (immediacy, intimacy and embodiment) of social presence. The quality of social interaction, the central notion of social constructivism, can be determined by analysing social presence in virtual learning and teaching environments (Kim, Kwon, & Cho, 2011). It also links to the connectivist factor of networking, but focusses on networking between students, and not those between online knowledge units.

3.5.4 Transactional distance theory

Moore (2013) states that his theory of transactional distance (TD) is derived from the understanding that distance teaching and learning events and virtual teaching and learning events, are not merely deviations from classroom teaching and learning. Instead they occupy a pedagogically different domain. The concept of transaction derives from Dewey and Bentley (1949) who describe it as the interactions that exist between individuals and the environment, as well as all the configurations of behaviours possible in the situation. Moore (1993, p. 22) groups into three elementary constructs the different types of interactions that can differ in character from those experienced in face-to-face teaching situations: "the structure of instructional programmes, the interaction between learners and instructors, and the nature and degree of self-directedness of the learner". These three constructs he then refines to develop the dimensions of his TD theory: structure, dialogue and learner autonomy. He also includes arguments on how these dimensions effect TD. The three dimensions of TD function like a see-saw with three beams. It attempts to find a balancing point - the configuration where non-face-to-face learning activity has the lowest transactional distance (Moore, 1993). Moore (1993; 2013) and Falloon (2011), focussing on instructor-learner interactions, argue that increased dialogue, increased student autonomy and looser activity structure lead to the lowest TD, with subsequent higher course satisfaction and improved learning outcomes in distance teaching and learning environments, as well as in virtual teaching and learning environments (Figure 3.5).

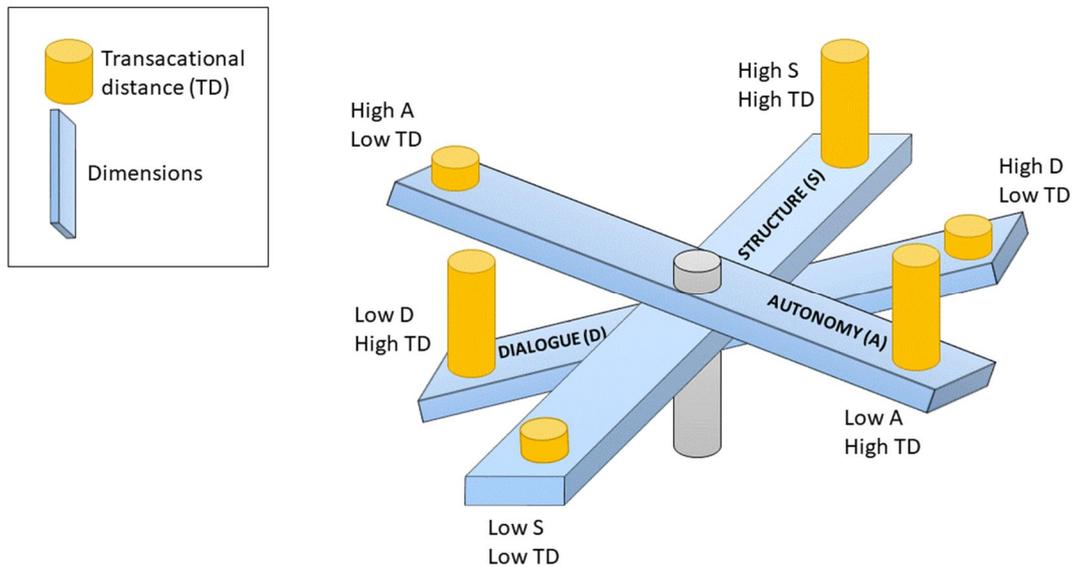


Figure 3.5: Three-beam see-saw as analogy of the interaction of Moore's (1993) transactional distance theory dimensions.

3.5.4.1 The dimension of dialogue

The concepts of dialogue and interaction are often used interchangeably. Moore (1993) however, clearly differentiates between these two concepts. He argues that dialogue consists of the positive, constructive and purposeful interactions between active listeners who are knowledge builders by building onto each other's contributions. Moore (1993) further notes that the quality of the dialogue is influenced by factors such as instructor-student ratio, the incidence of communication opportunities and the physical and emotional environments in which the teacher and learner find themselves in during the activities. These factors impact on the experience of transactional distance by the different parties. Moore (1993; 2013) suggests the existence of an inverse relationship between the level of dialogue and the level of TD in an activity. In other words, increased dialogue in non-face-to-face educational activities reduces the perception of transactional distance, and vice versa. In his conceptualisation of TD, Moore (1993) specifically focusses on the teaching-learning transaction when describing the spectrum of dialogue options within non-face-to-face educational activities and their impact on TD. In social constructivist virtual learning environments, dialogue between learners is just as relevant as instructor-learner interactions. This view has been confirmed by Zhang (2003) and substantiated by Paul, Swart, Zhang and MacLeod (2015) who find that, in virtual learning environments TD perception in learner-learner interactions is the main factor influencing learners' sense of

TD. This is followed by instructor-learner interactions that influence learners' overall sense of TD in, and subsequent engagement with, activities.

3.5.4.2 The dimension of programme structure

The structure of non-face-to-face programmes can range from total rigidity to extremely flexible course structures. In totally rigid course structures students have to follow a pre-planned sequence of activities within specified, synchronised time frames, with scant accommodation for student needs. Extremely flexible course structures allow students the freedom to follow different pathways through activities, within time frames that cater for each student's own needs (Moore, 1993; 2013). To ensure rigidity in highly structured programmes, dialogue opportunities are often restricted, leading to a sense of high transactional distance (Moore, 1993). A more flexible programme structure supports dialogue opportunities, and therefore a decrease in transactional distance. This argument for an inverse interdependency between structure and dialogue is also confirmed by Saba and Shearer (1994). Vrasidas and Mclsaac (1999), however, disagree with Moore (1993) and Saba and Shearer (1994) when evaluating TD in virtual educational environments. Vrasidas and Mclsaac (1999) argue that, in virtual collaborative learning structures, highly structured programmes can support active dialogue and therefore lower TD. The researcher agrees with So and Brush (2008) who also found this direct interdependency in their study on collaborative learning, and who argue that it does not contradict Moore (1993). They find that it rather adds a sub-dimension to the TD theory. So and Brush (2008) reason that Moore's (1993) TD theory focussed only on instructor-learner interactions. Therefore they, as well as Vrasidas and Mclsaac (1999), additionally focus on the sub-dimension of learner-learner interactions.

3.5.4.3 The dimension of learner autonomy

According to Moore (1993) non-f-2-f learning environments require students who want to set their own learning goals, want to shape their own learning experiences and who have the desire to self-evaluate their progress through a learning activity. These characteristics are linked to the notion of learner autonomy. The reality is that, just like in the f-2-f learning environment, students in non-f-2-f learning environments can range from highly autonomous learners to those who need assistance every step of the way (Dron, 2007; Moore, 1993; 2013). Different students will therefore react differently to the same programme. This means that, whereas the instructor of a non-f-2-f programme can manipulate the dimensions

of dialogue and structure, learner autonomy is a student attribute and not under the control of the instructor (Huang et al., 2016; Moore, 1993; 2013). Moore (2013) further proposes that students who function on a low level of autonomy are more comfortable in settings where TD is low, whereas students presenting with a high level of learner autonomy are at ease in settings with a high TD.

Social constructivism, which is socially mediated within a context of collaborative dialogue, speaks to the dialogue dimension of TD theory. In both, increased dialogue underpins knowledge construction (Barak, 2017; Moore, 2013; Yilmaz, 2017). Likewise, in TD theory higher levels of student autonomy create space for students to explore broader than the confines of tightly structured contexts and consequently enhance active construction of knowledge (Benson & Samarawickrema, 2009; Kemme, 2017). Three connectivist factors that are seen as extensions of social constructivist learning theory (Trnova & Trna, 2017), autonomy, openness and connectedness (Tschofen & Mackness, 2012), also resonate with TD theory (León, Morales, & Vértiz, 2017). For the fourth draft of the conceptual framework teaching presence, social presence and transactional distance were added to inform the effective online support of TPL students (Figure 3.6).

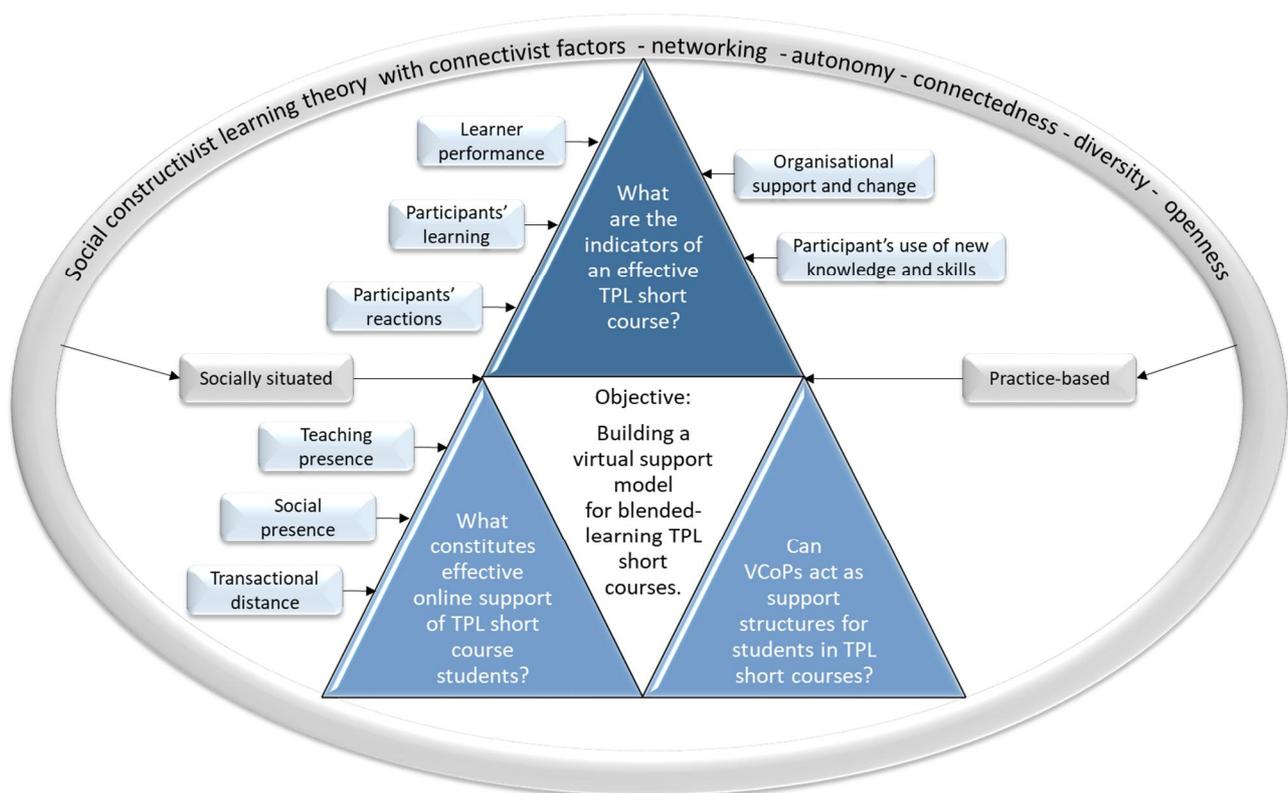


Figure 3.6: The fourth draft version of the conceptual framework.

3.6 VCoPs as support structures in TPL short courses

VCoPs, as with f-2-f CoPs, are grounded in the social constructivist learning theory that views learner-learner interaction as the quintessence of knowledge construction (Vygotsky, 1978). They also have theoretical roots in social interdependence theory (Thibaut & Kelley, 1959) that attempts to define learning within groups. In Chapter 1 WhatsApp, as preferred choice of platform for the VCoPs in this study was discussed. The accessibility and monetary motives alone would however be short-sighted motivations if social media, and specifically WhatsApp, does not possess the affordances needed to sustain social interdependence and VCoPs.

3.6.1 Social interdependence theory

In their book, *The Social Psychology of Groups*, Thibaut and Kelley (1959) first formulated the social interdependence theory to describe how learning takes place within groups. This idea of group or socially situated learning was originally proposed by one of the founder members of the Gestalt School of Psychology, Kurt Koffka (1935), who suggested that a group is not just a loose association between members, but a dynamic interplay of interdependent members. The amount of interdependence among members can however vary. This idea of a dynamic interdependence within groups was also proposed by Kurt Lewin (1948), who asserts that groups are not defined by the similarity or dissimilarity of its members, but by the amount of interdependence perceived by its members. Although Lewin specifically studied Jewish groups during the Second World War, Brown (1988) and Johnson and Johnson (1989, 2002) subsequently showed the existence of at least an elementary sense of interdependence within functional groups in many different group settings. Johnson and Johnson (1989, 2002) further define positive interdependence as an interaction where individuals in a group facilitate and encourage each other in the learning process. This peer facilitation and encouragement make the formation of VCoPs important for blended-learning programmes.

Deutsch (1949, 1962) and Johnson, Johnson, Roseth and Shin (2014) describe social interdependence as members of a group sharing mutual common goals, where each member's goal attainment is influenced by the activities and contributions of the other members. This definition resonates well with Wenger, McDermott and Snyder's (2002) descriptions of CoPs as groups of people sharing a concern or set of problems and who, through interaction, deepen the knowledge and expertise of every individual in the CoP.

One of Wenger's (1998) five essential traits of a CoP is learning through participation. Wenger (1998) argues that CoPs create a perfect match between knowing and learning, as it provides members with the pedagogical process through which knowledge is acquired, shared and built upon.

But does this theory of social interdependence still hold true for virtual groups, where there may be little or even no physical contact between participants? A major finding of Koh and Kim (2003) is that f-2-f activities in VCoPs play a critical role in creating a perception of virtual community and social interdependence. Barnett, Jones, Bennet, Iverson and Bonney (2012), Booth, Tolson, Hotchkiss and Schofield (2007) and Tolson, Booth and Lowndes (2008) concur that social interdependence in VCoPs can be strengthened through f-2-f activities. The influence of f-2-f activities is, however, questioned by Grabher and Ibert (2014) who argue that VCoPs afford unique social dynamics that might even be unattainable in f-2-f contexts. Grabher and Ibert (2014) concur with Murillo (2008) who provides evidence that VCoPs can develop within pure online contexts. The VCoPs proposed for this study will, however, function within blended-learning short courses that consist of both f-2-f and virtual activities.

3.6.2 Social media: Affordances and perceived affordances

Gibson (1977) coined the term 'affordance'. It describes specific combinations of properties of an object or organism that afford a set of probable activities that a human could possibly perform with that object, or that the organism needs to perform and survive in its environment. As an example of a physical affordance of an object both Gibson (1977) and Norman (1988) refer to chairs. The specific combination of the properties of a flat surface (*property 1*) that is raised from the floor (*property 2*) to a specific distance, about knee high (*property 3*), gives a chair the affordance of being 'sit-able'. Affordances are however not only bound within a physical context, but as Kirschner, Strijbos, Kreins and Beers (2004) argue, can also lie within a social, educational or technological context. Another lens through which a sub-group of affordances can be viewed is what Norman (1999, 2008) refers to as perceived affordances. An example of this could be when a person in anger throws a chair, perceiving the chair to have the affordance of 'throw-ability' and 'anger-release-ability'. Perceived affordances are therefore "in the eye of the beholder" and not intrinsically a property of an object. Zhao, Liu, Tang and Zhu (2013) propose that the

perceived affordances of social media can be categorised into four types: perceived physical, perceived cognitive, perceived affective and perceived control.

The perceived physical affordances of social media, such as WhatsApp, are the physical properties of vision (e.g. images and emojis) and audition (e.g. video and voice notes) that simplify human-computer interactions by replacing the need for long, text-only descriptions (Ghamdi et al., 2016; Te'eni, Carey, & Zhang, 2007). The user's perceptions of social media's ability to support cognitive processes, such as conceptualisation, analysis and problem-solving, maps to the second type, namely perceived cognitive affordances (Zhao et al., 2013). In social media groups, information and knowledge are gathered, exchanged and reconstructed by users, albeit usually in a social context, clearly aligning it with perceived cognitive affordances (Arfini, Bertolotti, & Magnani, 2017). The third type of perceived affordance is perceived affective affordances, where some social media platforms can encourage emotional reactions in the users through for example "like" icons. These icons allow users to quickly comment on user generated content (Zhao et al., 2013). Kaye, Malone and Wall (2017, p. 67) describe the presence of emoticons (emojis functioning to portray emotions in non-verbal communication) as "a toolkit for clarifying emotional concepts". Yuasa, Saito and Mukawa (2011) confirm that emoticons in social media discussions activate brain locations that deal with verbal and non-verbal communication more strongly than in pure text discussions. WhatsApp, which has an extensive group of easy to add emoticons, thus aligns with the perceived affective affordances too. Perceived control affordances are the fourth type. This type focusses on attributes that afford the user a certain amount of control within the social media environment (Zhao et al., 2013). WhatsApp members now have different options to delete messages, albeit within a very short time frame, as well as the option to mute or leave a group at their convenience (WhatsApp Inc, 2018). Gachago et al. (2015) and Pimmer and Pachler (2014) added one more type of affordance to Zhao, Liu, Tang and Zhu (2013)'s proposed list of four perceived affordances of social media platforms, namely that of a boundary object.

3.6.2.1 The theoretical notion of boundary crossing as a perceived affordance

To learn is to cross boundaries. Whether changing from novice to expert in a field of study, or increasing your participation from a peripheral to a full member of a learning community, social constructivist learning is grounded in the notion of moving from knowledge that has not been constructed yet, to assimilated constructed knowledge (Akkerman & Bakker,

2011). When an artefact acts with a bridging function to support *boundary crossing*, such an object is referred to as a *boundary object* (Star & Griesemer, 1989). Teachers participating in TPL short courses find themselves continuously having to cross boundaries between the formal university programme learning context and their informal work-based learning context at the institution where they are teaching. Timmis (2012) has shown that social media platforms, such as WhatsApp, can act as boundary objects by forming a bridge between students' social use of these platforms and formal work or study related use. Students' effortless boundary crossing between social use and study related use was also confirmed by Kumpulainen and Mikkola (2014). At the same time, social media groups create learning connections and facilitate increased immediacy between teachers who work and study in isolated, rural areas (Gachago et al., 2015; Pimmer & Pachler, 2014). Boundary objects that span several contexts and that create matrices within which learning can take place, resonate with the concept of learning ecologies (Barron, 2004). Barron (2004) defines virtual learning ecologies as co-located virtual spaces that include activities and material resources, as well as relationships, within which learning opportunities that span contexts are created. The WhatsApp platform is therefore not only a platform of choice for this study due to access and monetary motivations. It also maps to social constructivist learning, to all five perceived types of affordances needed to support the design of a model of social media support, and to the concept of learning ecologies.

3.7 Conclusion

In this chapter the guiding theoretical framework for this study was weaved from four different theoretical threads. The first is Guskey's (2002) five levels of effective TPL short courses. These levels act as lens for the researcher to evaluate whether the model that is being designed supports TPL effectiveness. As a second thread, social constructivism, with connectivist factors forming the learning theory lens for the whole study, highlights social situatedness and teachers' need for practice-based interventions. This informs the researcher about the support needs of teachers in TPL short courses. The third thread combines teaching and social presence with transactional distance theories, to frame the design of a model for support in online environments. The final thread focusses on social media as boundary object and its perceived affordances to theoretically motivate the specific use of WhatsApp in the design of the VCoP support model.

Miles, Huberman and Saldana (2013) define a conceptual framework as a graphical or narrative map of the interrelationship of the main factors, variables or constructs of the research study's terrain. In DBR the conceptual framework not only informs the design and analysis phases of the study. It also evolves during the study to lead to a theoretical model, or in the confines of a doctoral study, to at least a set of design principles to inform the educational community. These design principles can then be drawn upon to inform further studies and educational policies. (Goff & Getenet, 2017).

The methodology and research design will be informed by the conceptual design as presented in Figure 3.7.

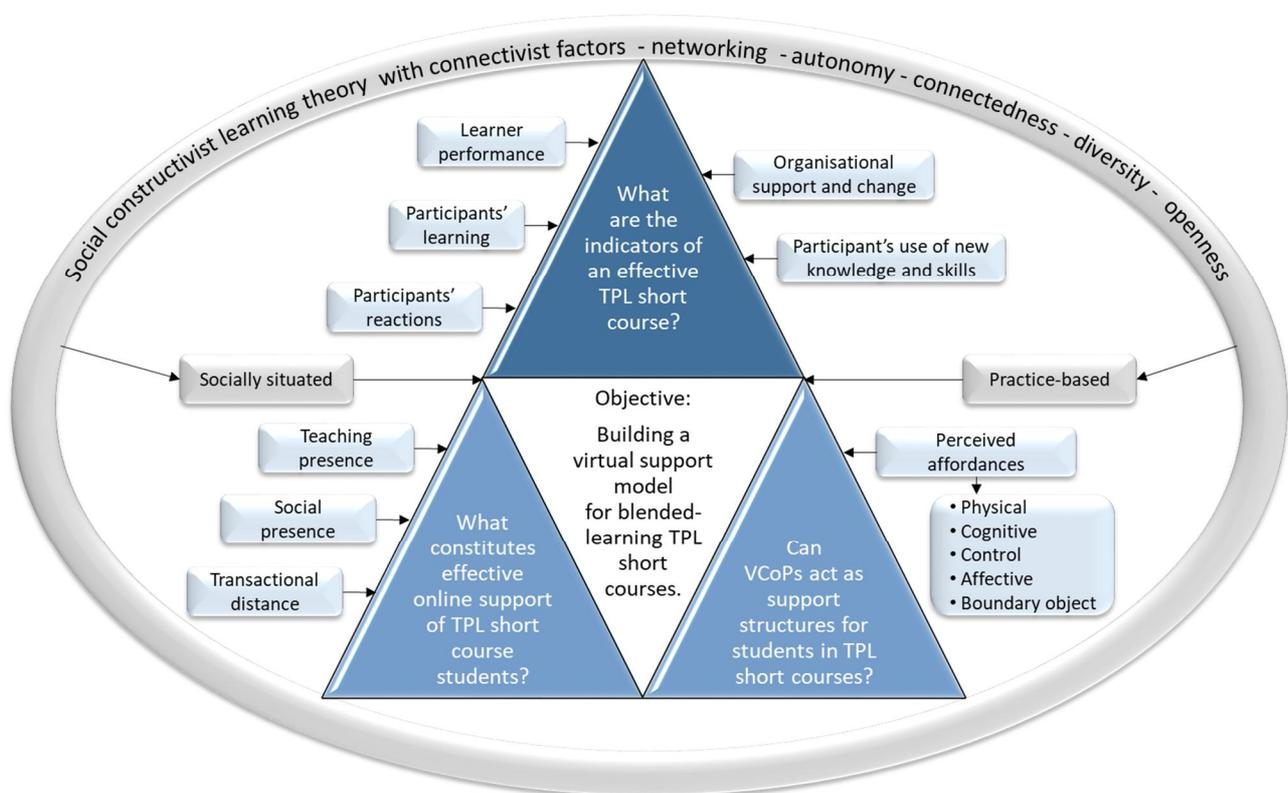


Figure 3.7: The conceptual framework of this study.

In the next chapter the research paradigm, methodology and research design of this study will be presented.



BUILD

CHAPTER 4: RESEARCH METHODOLOGY

“Easy-to-do science is what those in physics, chemistry, geology, and some other fields do. Hard-to-do science is what the social scientists do and, in particular, it is what we educational researchers do. In my estimation, we have the hardest-to-do science of them all!”
(Berliner, 2002, p. 18)

4.1 Introduction

In this chapter the research paradigm, as informed by the study's epistemology and ontology, is presented. This is followed by discussions of the methodology, research design and research process used to develop the WhatsApp support model. This chapter represents step 5 (*build the solution*) of the Easterday, et al. (2017) seven-step iterative process for DBR. Education is a human endeavour derived from the human mind and therefore inexplicably intertwined with the variety of human cultural values and norms (De Vries, 2018; Richter & Allert, 2017). Effective, relevant and practical solutions to educational problems can therefore never be completely generalisable, but should be designed for specific educational contexts (De Vries, 2018; Plomp & Nieveen, 2007). It is no wonder then that Berliner (2002, p. 18) posits that "education is the hardest science of all". Figure 4.1 provides a detailed outline of this chapter.

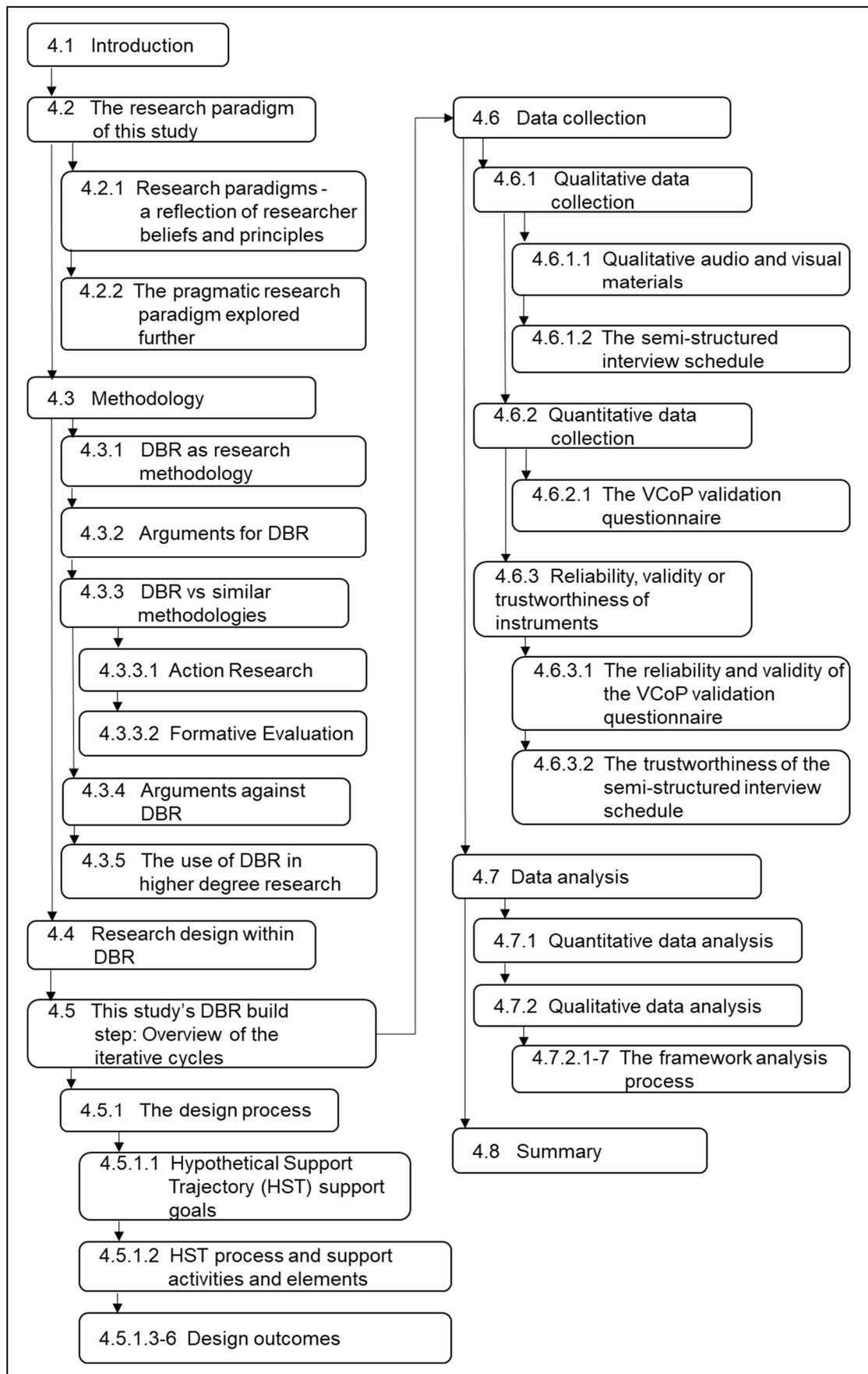


Figure 4.1: Chapter 4 outline.

4.2 The research paradigm of this study

In Chapter 1, DBR was posed as research methodology within a pragmatic research paradigm. In this section the researcher's understanding of the different research terminologies, and an explanation for why pragmatism was chosen as research paradigm for this study, are given.

4.2.1 Research paradigms – a reflection of researcher beliefs and principles

The term paradigm originated in the 15th century from the Greek word “paradeigma” that refers to patterns or models. According to Kivunja and Kuyini (2017) the first use of the term paradigm, to describe a philosophical way of reasoning in the modern era, is found in Thomas Kuhn’s (1962) *The Structure of Scientific Revolutions*. In educational research, where various research terminologies developed different meanings from their original strictly philosophical meanings, Guba and Lincoln (1994) define research paradigms as educational researchers' belief systems that guide any research actions they take. In the same vein, Denzin and Lincoln (2005) describe research paradigms as human constructed principles that inform the educational researcher, and the reader of the resultant products of the study, on how to find constructed meaning within the study. Each research paradigm is influenced by the study’s epistemology and ontology. The combination of epistemology and ontology informs the types of methodologies, research methods and axiologies possible within the research paradigm (Denzin & Lincoln, 2005; Guba & Lincoln, 1994). The epistemology and ontology also determine the possible validation criteria (Kivunja & Kuyini, 2017). Figure 4.2 presents a diagrammatic representation of the relationship between the various research terminologies.

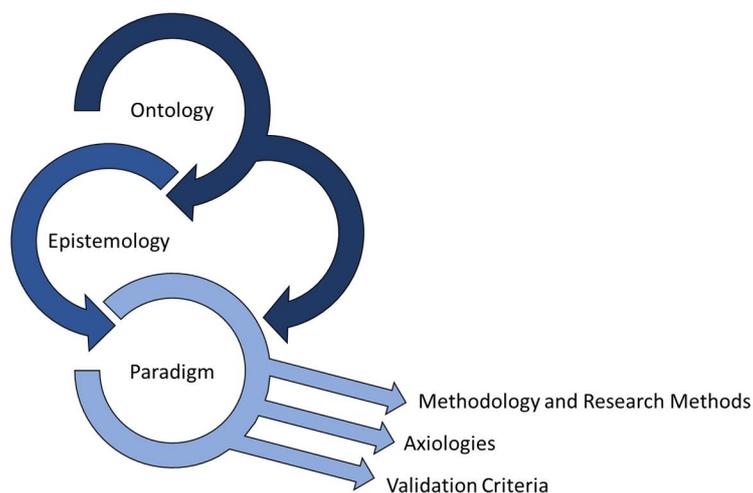


Figure 4.2: Representation of the relationship between the various research terminologies.

Ontology attempts to describe the researcher's assumptions about the nature of reality and truth. In other words, how does the researcher know the object (living or non-living) being studied is real? Ontologies can be naïve realist, relativist, historical realism or non-singular realities.

- **Naïve realist** – the researcher accepts the following five tenets (Putnam, 2012; Searle, 2015): (i) Material objects are real, (ii) through sensory experiences, some of these objects' characteristics can be known, (iii) objects are perception-independent: they exist whether they are perceived or not, (iv) characteristics of objects are perception-independent: they are always the same and (v) knowledge obtained through sensory experiences are justified.
- **Relativist** – every situation has multiple realities that can be explored, understood and reconstructed during human interactions (Chalmers, Manley, & Wasserman, 2009).
- **Historical Realism** – as a form of realism, researchers following this ontology still argue for a single reality, but in the context of all the possible influences that have impacted the object, such as social, cultural, political, economic, gender or ethnic factors (Guba & Lincoln, 1994).
- **Non-singular reality** – every human object in a study has his or her own and distinctive understanding of reality, including the researcher's own reality (Kivunja & Kuyini, 2017).

This study has a non-singular reality ontology, as each member of each VCoP's perceptions will be probed. This implies that each member, as well as the researcher, has his or her own and distinctive understanding of reality.

Epistemology speaks to the relationship between the researcher and the object (living or non-living) under investigation, and can be objectivist, subjectivist or relational:

- **Objectivist** – the object being investigated and the investigator can function independently, and within the research context will not be influenced by each other (Guba & Lincoln, 1994).
- **Subjectivist** – the object being investigated and the investigator are interactively linked, thereby creating findings during the investigative process (Guba & Lincoln, 1994).

- **Relational** – the relationship between the object and the researcher depends on the researcher, who chooses an appropriate relationship (objectivist or subjectivist) for each particular study or part of a study (Kivunja & Kuyini, 2017).

This study has a relational epistemology, as the development of a support model for teachers during TPL short courses will require both objectivist and subjectivist relationships during different parts of the study. Kivunja and Kuyini (2017), in a review of pertinent literature, attempt to clarify the four dominant research paradigms that relate to research in educational contexts. They show how each paradigm is influenced by its own pairing of ontology and epistemology, which leads to distinct methodologies and research methods, axiological characteristics and validation criteria. Following Kivunja and Kuyini's (2017) proposed characteristics of the different research paradigms within an educational research context, a non-singular ontology, coupled with a relational epistemology, leads to a pragmatic paradigm (Figure 4.3).

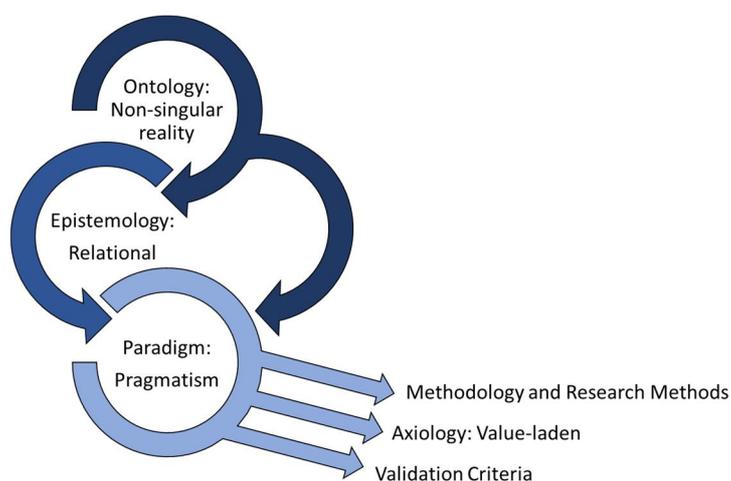


Figure 4.3: This study's ontology, epistemology and paradigm.

4.2.2 The pragmatic research paradigm explored further

Of the three founding fathers of pragmatism, John Dewey (1859-1952), William James (1842-1910) and Charles Sanders Peirce (1839-1914), only Dewey was an educationalist (Biesta & Burbules, 2003) and therefore probably had the deeper insight into pragmatism within an educational context. Each of the three founders has a slightly different slant to exactly what pragmatism entails. Dewey, as educationalist though, best understood the intertwined nature of theory (questions of knowledge) and practice/action (acquisition of knowledge) that is education (Biesta, 2013). This interplay between action and theory is what makes pragmatism appropriate as research paradigm for studies that intervene into

complex contexts. These studies find workable solutions, as attempted within the DBR methodology, in contrast to those studies that merely aim to explain and predict, or aim to understand and interpret (Braa & Vidgen, 1999; Goldkuhl, 2012). Pragmatism rejects the need for a study to be either positivist or interpretivist, but seeks to employ every stance that can aid in knowledge construction in informing appropriate action (Kivunja & Kuyini, 2017). Pragmatism flows from a non-singular reality ontology. However, different proponents of pragmatism differ on how people perceive or construct their own reality. Dewey, in his 1925 paper *Nature, Communication and Meaning*, saw meaning as a social construct, supported by language as communication method in positive collaborative partnerships (Dewey, 2008). Social constructivism as learning theory therefore supports the Deweyan pragmatic research paradigm and links to this study's conceptual framework.

The non-singular reality ontology and relational epistemology of pragmatic studies cannot be supported by a single method methodology, but suggest a mixed method approach (Kivunja & Kuyini, 2017). Creswell and Plano Clark (2011) describe the central premise of mixed method approaches as the combined use of qualitative and quantitative approaches, to ensure a depth of understanding that would not be possible using either approach on its own. In section 4.3 the methodology of this study will be interrogated further. Also, flowing from the paradigm of any study is its axiology and validation criteria.

Axiology attempts to address which ethical considerations within the researcher's research paradigm will guide the researcher's behaviour during the study. Axiologies can be beneficence, balanced, respecting of cultural norms or value-laden:

- **Beneficence** – from the root 'benefit'. It requires the researcher to aim for the best possible outcome of a research project to benefit both the research participants and humanity in general (Mertens, 2015).
- **Balanced** – it is expected of the researcher to constantly reflect on the values of the researcher and those of the human object, in order to ensure a balanced view of the findings (Kivunja & Kuyini, 2017).
- **Respecting of cultural norms** – the researcher must at all times be aware of the cultural norms of the human objects in a study and attempt to respect those norms at all times (Kivunja & Kuyini, 2017).
- **Value-laden** – the researcher must keep in mind that the main value focus of the research is to benefit human beings.

Kivunja and Kuyini (2017), in a review of pertinent literature, attempt to clarify the four dominant research paradigms that relate to research in educational contexts, placing each within its own set of epistemological, ontological, methodological and axiological characteristics. The following diagram is the researchers' interpretation of Kivunja and Kuyini's (2017) lens on educational research paradigms (Figure 4.4):

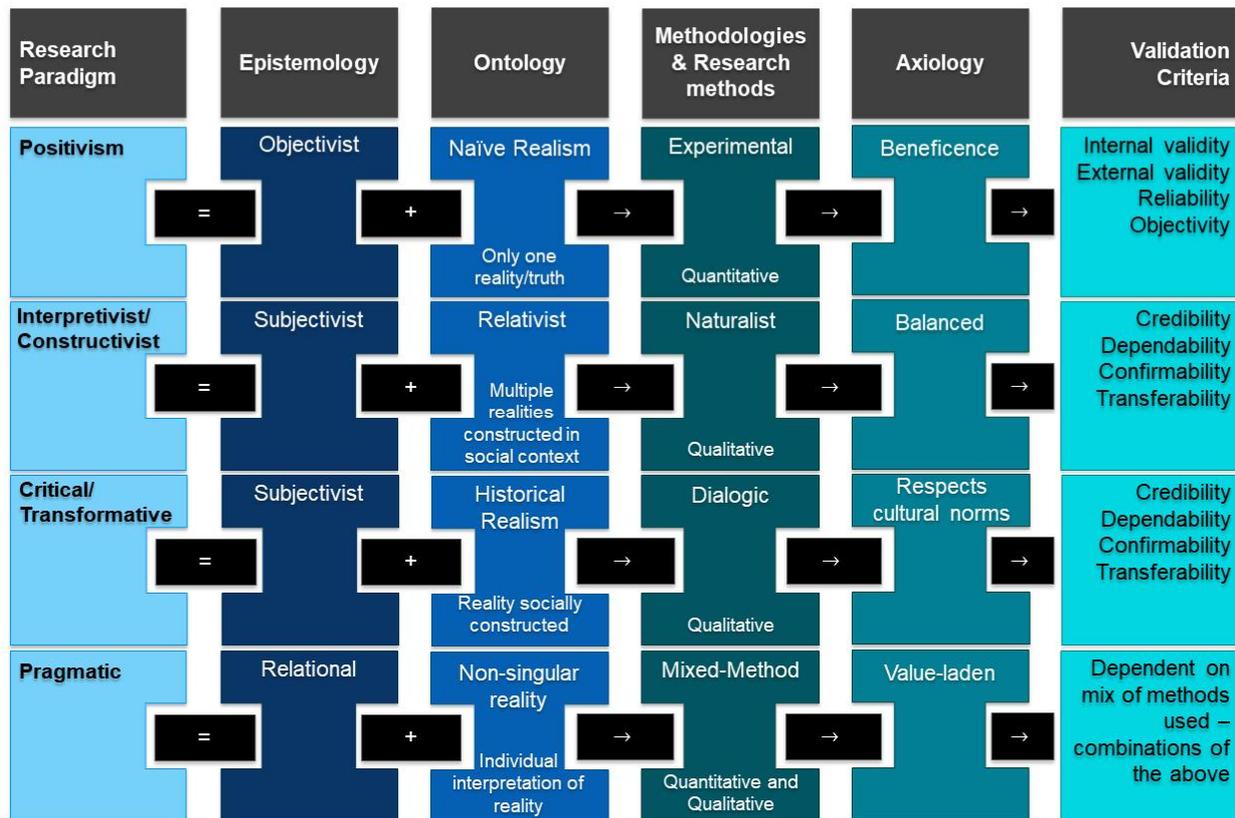


Figure 4.4: The researcher's interpretation of Kivunja and Kuyini's (2017) four main research paradigms in educational contexts.

The teachers within this study will need to interact in different models of VCoPs for the researcher to find the model that best supports the teachers' learning. This, together with the study's pragmatic paradigm, presume a value-laden axiological context.

4.3 Methodology

As mentioned in the previous section, methodologies within a pragmatic research paradigm align with mixed method approaches. From the viewpoint of educational research, De Vries (2018) and Erickson and Gutierrez (2002) likewise propose that this field of research cannot be narrowly demarcated into using either quantitative or qualitative methodologies. It should rather make use of mixed method approaches to effectively interrogate the dynamic and chequered context of educational practice. Amiel and Reeves (2008) are of the opinion that

educational technologies can have the affordance of reducing educational inequities when used as part of a systematic educational process, instead of being seen as an educational tool causing guaranteed educational success. They also argue that, when introducing technology within an already complex system such as education, narrow, mono-method and once-off intervention type research methodologies cannot offer rich, value-laden insights into the effectiveness of the technology. Reeves (2006) proposes that the only methodology that can effectively interrogate such a complex system is Design-Based Research (DBR). He further states that the cornerstone principles of DBR are:

...addressing complex problems in real contexts in collaboration with practitioners; integrating known and hypothetical design principles with technological advances to render plausible solutions to these complex problems; and conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to define new design principles (Reeves, 2006, p. 58).

4.3.1 DBR as research methodology

There is currently no consensus as to whether DBR is a research methodology or a research design. Wang and Hannafin (2005) argue that DBR is a hybrid research methodology that combines traditional research and design methodologies, while also extending current methodologies. They contend that DBR as research methodology is not only theoretically grounded, but also supports systematic theorising, impacting both theory and practice in educational environments.

Hoadley (2007) argues that two major methodological traditions have predominantly informed research in education thus far. Research within the positivist tradition presumes that educational environments can be studied through controlled experimentation, leading to the uncovering of theories that predict solutions for all educational environments in the future (Levin & O' Donnell, 1999). In contrast ethnographic and anthropological methodologies presume that educational environments have such unique social contexts that description and interpretation of observation are more important than predicting future outcomes (Lincoln & Guba, 1985). Whereas these two traditions are usually seen to oppose each other, Hoadley (2007) argues that DBR embraces both traditions by acknowledging the uniqueness of educational environments, while attempting to uncover empirical theories or design solutions for enhanced learning through interventionist strategies. Just as proposed by Wang and Hannafin (2005), Hoadley (2007) also suggests that DBR might not

offer a new distinct separate tradition, but should rather be seen to provide a new integrative methodology as solution in educational and learning science research.

When Kelly (2004) interrogates DBR as research methodology, he argues that a mature methodology has to include at least the following characteristics: have its own argumentative grammar, address meaningful problems, be generalisable over actors, behaviours and contexts, and produce usable knowledge. In traditional research methodologies argumentative grammar is linked to prescribing a specific choice of methods, either quantitative or qualitative. Based on the propositions of Wang and Hannafin (2005) and Hoadley (2007) that DBR is a pragmatic hybrid or integrative methodology, it follows that the DBR researcher has access to a much wider selection of methods than oppositional traditional methodologies allow. That is not a deterrent, but actually a strong point of DBR. The lack of generalisability of DBR findings is also seen by Kelly (2004) as weakening DBR as methodology. This weakness is not unique to DBR, but shared with qualitative research approaches. It also shares the same strengths of qualitative designs, in that it can inductively lead to theory building. On the one hand, DBR shares the presumption of the traditional ethnographic and anthropological methodologies that social actors and contexts are so unique that generalisability is only possible within identical contexts and with similar actors. On the other hand, DBR's hybrid design means that it can use both qualitative and quantitative methods, and that makes it amenable to mixed method research designs. Generalisability can be questioned where different emphasis is placed on the mix of methods, symbolised as QUAL + quan or QUAN + qual (Palinkas et al., 2011). However, in this study equal emphasis was placed on both qualitative and quantitative methods (QUAL + QUAN). The two methodological approaches thereby create triangulation and consequently enhance generalisability. In this study, DBR is taken to be a research approach to educational design that qualifies it as a research methodology, making use of both qualitative and quantitative methods to collect data at each cycle of its implementation.

4.3.2 Arguments for the use of DBR in this study

In line with Reeves' (2006) pursuit for systematic educational processes, Bannan, Cook and Pachler (2016) contend that DBR allows educational researchers a more systematic scheme to investigate new technological possibilities within messy learning contexts. They also argue that mono-method, single cycle research methodologies cannot capture the intricacies of design processes that, as is the nature of the educational context, include a

lack of certainty, as well as multiple variability. Where traditional educational research methodologies attempt to find solutions within pre-determined, fixed research designs, DBR allows for iterative, reflective cycles of design and re-design (Bannan et al., 2016). Although DBR has its origins in design-based learning, which focusses on students designing and building prototypes in engineering or the sciences by incorporating an iterative, evolving design process (Collins, 1990; The Design-Based Research Collective, 2003), it differs from these fields in two distinct ways: (i) The focus of the design process is to exert a positive change in a learning environment and not only on designing a working prototype, while (ii) determining pedagogical principles that might apply, and be researchable, in homogenous contexts (Bannan et al., 2016).

4.3.3 DBR vs other similar methodologies

Easterday et al. (2017) and O'Neill (2012) are but some of the adherents of DBR who pose that current accounts of DBR do not always clearly define how DBR differs from other related forms of research. To address this issue and clearly delineate DBR in this study, two closely related methodologies, action research and formative evaluation, will be compared and contrasted with DBR in the following sections.

4.3.3.1 DBR vs Action Research

In both DBR and action research, real world problems are identified that lead to actions performed with the intent of improving of a current situation (Anderson & Shattuck, 2012). They also share the same pragmatist research paradigm (Cole, Purao, Rossi, & Sein, 2005). Whereas DBR specifically speaks to educational contexts, action research is applied in many other contexts, for example in community and organisational development (Coghlan & Brannick, 2014; Reason & Bradbury, 2001), as well as in health improvement work (Loewenson, Laurell, Hogstedt, D'Ambruso, & Shroff, 2014). The two most important differences between DBR and action research are their main goals and the roles of researcher and participants in the research process (Ørngreen, 2015; Reeves, Herrington, & Oliver, 2005). Action research aims to improve practices, while improving theoretical knowledge of those practices, whilst DBR has a dualist pursuit of theoretical goals: firstly by being grounded in theory and secondly by being enacted in order to generate theory (Wang & Hannafin, 2005). Furthermore, in action research the research usually originates from the participants' efforts to improve a situation that is then facilitated by researcher input, whereas

DBR is usually initiated and designed by the researcher, who is informed by participant input (Wang & Hannafin, 2005).

4.3.3.2 DBR vs Formative Evaluation

Formative evaluation is sometimes confusingly regarded to be identical to DBR, as both have an iterative and formative character. The main difference between these two methodologies is that formative evaluation's main focus is to enhance or perfect the practice of design - it does not have theory generation as goal, as is the case with DBR (Barab & Squire, 2004). Van den Akker (1999) even argues that formative evaluation is a major method within DBR and not a separate methodology, as it is the method the DBR researcher uses to detect the disparities between the design being tested and the ultimate design goal.

4.3.4 Arguments against DBR

As with all methodologies, but especially with the more recent additions like DBR, different critical perspectives can be found and should be investigated. Dede (2014) cautions that, if DBR research studies do not have well defined outcomes, they can morph away from the intended goal and ultimately may even have to be abandoned. As DBR research is a time consuming endeavour, Dede (2014) suggests that every DBR study should have standards that assist the researcher in identifying when the research is still on course or when it should be abandoned. Within this study only three iterations were performed within a partially pre-determined design pathway that aimed to keep the study on course. As another argument diSessa and Cobb (2004) contend that many DBR studies are theoretically under-conceptualised and that this lack of a proper conceptual framework negatively impacts the generation of new theory. The researcher is of the opinion that a solid theoretical and conceptual framework was created in Chapter 3 and that this study therefore does not fall prey to theoretical under-conceptualisation. Since the advent of DBR the large amounts of data that have to be collected during DBR iterations, and that have to be coordinated and analysed, have been a concern (Brown, 1992; Dede, 2014). Care was taken in this study to find rich qualitative data, rather than large sets of data, although the WhatsApp group data did end up being rather large. As the WhatsApp groups were quite small, the quantitative data was however of a manageable size. One of the recurring themes in arguments critiquing DBR is the difficulty in making generalisations about the findings, because of the adjustments made during each new iteration, and also because participants can differ between iterations (O'Donnell, 2004). The researcher though concurs with

Simmons (1996) and Bannon, Cook and Pachler's (2016) attempt to view this supposed difficulty from another angle. They propose that there is a need for the proposed tension between the unique and the generalisable, as this leads to a better understanding of the messy context of education. Simmons (1996) powerfully captures this unity between the unique and the universal when she states:

To live with ambiguity, to challenge certainty, to creatively encounter, is to arrive, eventually, at 'seeing' anew (Simmons, 1996, p. 238).

Finally the researcher fully agrees with Ørngreen (2015) that the unique and rare moments in the data can be crucial to understand changes in learning, and that generalisations should not be the only conclusions derived from DBR studies.

4.3.5 The use of DBR in higher degree research

In DBR studies the need for multiple design, test and formative evaluation iterations usually necessitates a long-term approach. This can be viewed as problematic within time-constrained studies such as higher degree research (Amiel & Reeves, 2008; McKenney & Reeves, 2012). On the other hand, DBR allows a higher degree research student the opportunity to conduct authentic, in-context and localised investigations by taking on both the roles of instructor and researcher (Kennedy-Clark, 2013). Herrington, McKenney, Reeves and Oliver (2007) go so far as to recommend that students that consider doing a doctoral study in the educational field should be encouraged to use DBR. They argue that the lack of impact of education research over the years can be directly related to the gap that exists between students' theoretical understanding and their skills in practical application. According to Herrington, McKenney, Reeves and Oliver (2007) DBR offers students the chance to combine robust design with theoretical and practical research results that could impact the field of education more profoundly, and that the presumed time-constraint challenge can be overcome with careful planning. Wang and Hannafin (2005), Pool and Laubscher (2016) and Goff and Getenet (2017) argue that relatively short DBR studies are possible within the confines of a plausible doctoral study. They highlight the adaptability of DBR, especially regarding the duration and number of iterations within each study (Table 4.1):

Table 4.1:
Examples of relatively short DBR studies

Authors	Topic of study	Country	Number of iterations	Combined duration of iterations
Hakkarainen (2009)	Designing and implementing a PBL course on Educational Digital Video products (Article)	Finland	1 cycle • 3 meso cycles	6 weeks
Sandoval and Reiser (1998)	The design and study of a technology-supported curriculum to develop students' abilities to construct their own scientific knowledge (Article)	United States of America	6 cycles • 3 groups x 2 cycles	3 months
Kizito (2012)	Developing a diagnostic tool for mathematical concepts on a mobile phone (Article from PhD)	South Africa	3 cycles	3 years
Doorman, Drijvers, Gravemeijer, Boon, & Reed (2013)	Designing and evaluating a technology-rich learning arrangement that may foster conceptual development of function in mathematics (Article)	Netherlands	3 cycles	3 years

DBR is therefore a suitable, and even desirable methodology for short-term projects such as doctoral dissertations.

4.4 Research design within DBR

Educational research is usually classified as either research-about-education or research-for-education. Juuti and Lavonen (2006) interpret the former as having an intellectual objective to make theoretical sense of teaching and learning, and the latter as having a pragmatic objective to enhance teaching and learning praxis. Heap (1992) distinguishes in social sciences research, under which educational research falls, between 'research-as-science' and 'research-as-project'. Research-as-science is aligned to recognised and consistent theoretical frameworks, whereas research-as-project links across conceptual frameworks, thereby leading to the need for mixed formats and methods. DBR is an iterative design process with such a dual-purpose research type (Mohrman & Lawler III, 2011), combining the aims of developing "innovative educational environments" (Brown, 1992, p.141) with the development of practice-relevant theories (Euler, 2017). The iterative process of DBR has been presented diagrammatically in numerous ways. One of the first representations was made by McKenney (2001) in her published doctoral thesis, with the

diagrammatical graph (Figure 4.5) focusing on what she argues as the three main phases of DBR: (i) needs and context analysis, (ii) design, development and formative evaluation and (iii) semi-summative evaluation.

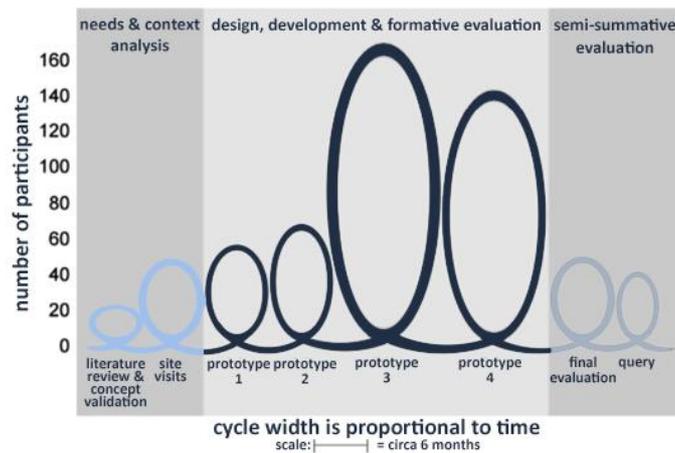


Figure 4.5: McKenney's (2001) diagram of the CASCADE-SEA project²⁰.

Reeves's (2006) representation (Figure 4.6) consists of four phases with a special focus on the formative evaluation feedback possibilities between different phases.

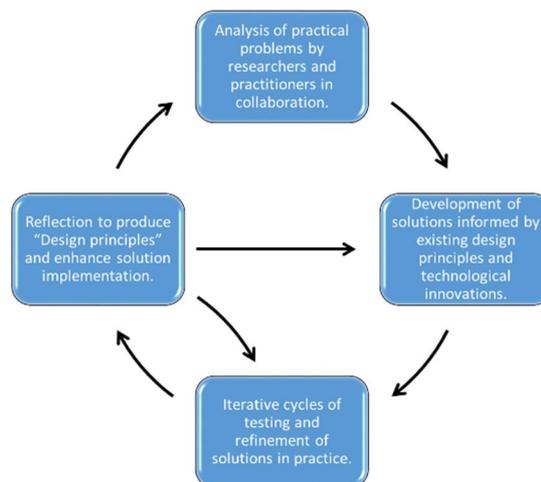


Figure 4.6: The Design-Based Research approach (Researcher adaptation of Reeves, 2006, p. 59).

There have been three decades of DBR studies, ranging from Brown's (1992) early descriptions of the process to edited volumes and books by Van den Akker (1999), Plomp and Nieveen (2007), Kelly, Lesh and Baek (2008), and McKenney and Reeves (2012), to name but a few. Anderson and Shattuck (2012, p. 24) though, still conclude that "as promising as the methodology is, much more effort ... is needed to propel the type of

²⁰ Author permission received for use of diagram – see Addendum B

education innovation that many of us feel is required”. In answer to Anderson and Shattuck (2012), and heeding the call of Hoadley (2004) that criticisms against DBR should challenge supporters of DBR to more rigorously define the methodology, Easterday et al. (2014) rose to the challenge and formulated a six-step, iterative design process for DBR. The six steps of their design process are: “*focus* the problem, *understand* the problem, *define* goals, *conceive* the outline of a solution, *build* the solution and *test* the solution”, and require formative evaluation nested in, and between, each step (Easterday et al., 2014, p. 319). See Figure 4.7.

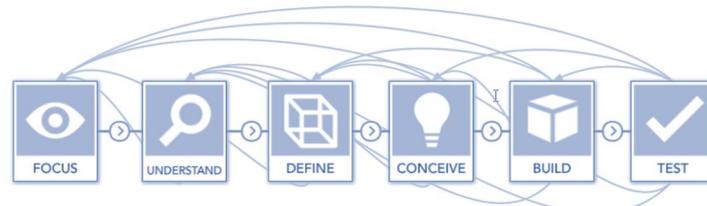


Figure 4.7: Easterday et al.’s (2014) six-steps of the iterative DBR design process.

At the start of this study Easterday et al.’s (2014) design process provided a clear and logical definition to guide this DBR study. What seemed to be lacking was a final step where the results of the DBR study could be communicated to the research community and/or key stakeholders. Easterday et al. (2017) noticed this deficiency and broadened their definition to include a seventh step, namely present the solution (Figure 4.8).

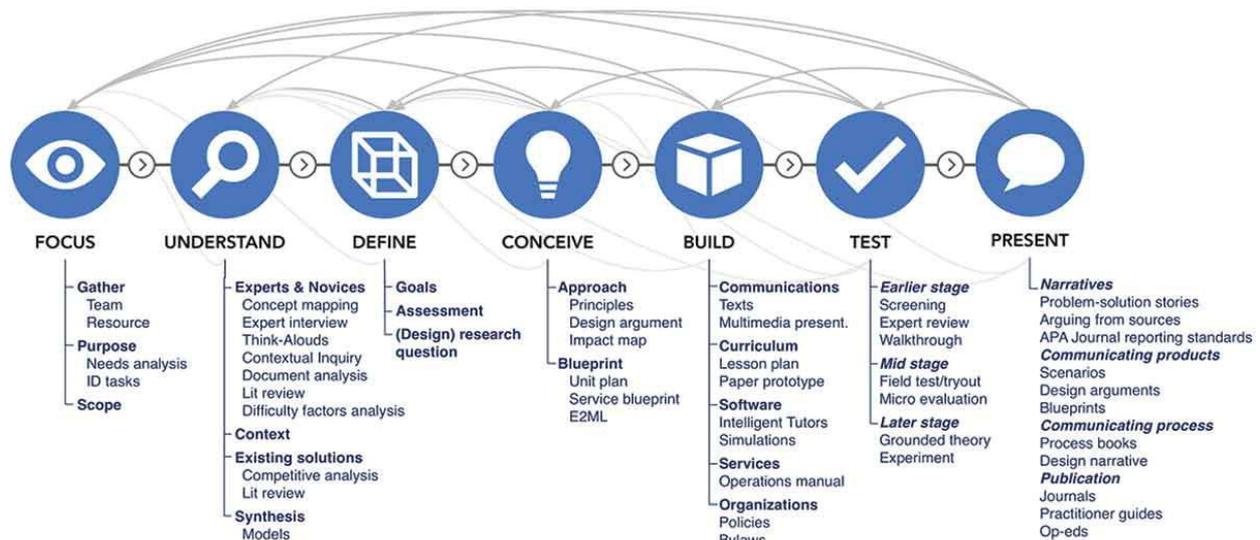


Figure 4.8: Easterday et al.’s (2017) seven-step iterative DBR process²¹.

²¹ Images in Figure 4.9 and 4.10 are from Open Access articles distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>) that permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

For both the research design and chapter layout (Chapter 1, section 1.14) of this study, the Easterday et al.'s (2017) seven-step process was followed.

4.5 This study's DBR build step: Overview of the iterative cycles

This study includes three iterative cycles and formative, as well as retrospectively summative evaluation. The WhatsApp group for each course consisted of the research participants, teachers teaching either Natural or Life Sciences²² in two provinces of South Africa, and the course facilitators. In all three groups the researcher was also a facilitator. In the second group one Northern Cape Education Department official also attended the course and joined the WhatsApp group. In the third group one of the facilitators was also a mentor. The participating teachers attended blended-learning TPL short courses presented by SUNCEP in 2015 and 2017. SUNCEP did not present any Natural or Life Sciences short courses during 2016 (Table 4.2).

Table 4.2:
Overview of the participants and course structure of the iterative cycles.

	Iterative cycles		
	1	2	3
Participants	<ul style="list-style-type: none"> Teachers (n=38) TPL facilitators (n=3) Researcher (n=1) 	<ul style="list-style-type: none"> Teachers (n=28) NCED official (n=1) TPL facilitators (n=2) Researcher (n=1) 	<ul style="list-style-type: none"> Teachers (n=15) Mentor (n=1) TPL facilitators (n=3) Researcher (n=1)
Physical area in which teachers teach	Western Cape Province, South Africa	Northern Cape Province, South Africa	Western Cape Province, South Africa
TPL course subject and year	Natural Sciences, 2015	Life Sciences, 2017	Natural Sciences, 2017
Length of course	Contact sessions: <ul style="list-style-type: none"> 3 + 2 days over 4 months WhatsApp Group: NS2015 <ul style="list-style-type: none"> Started two weeks before start of course 5 months duration 	Contact session: <ul style="list-style-type: none"> 3 days WhatsApp Group: LS2017 <ul style="list-style-type: none"> Started at end of contact session 4 months duration 	Contact sessions: <ul style="list-style-type: none"> 2 + 2 + 2 days over 2 months WhatsApp Group: NS2017 <ul style="list-style-type: none"> Started a week before start of course 4 months duration

Note: Only members of the various WhatsApp groups who agreed to be part of the study, are shown as participants. There were a few WhatsApp group members in Cycles 1 and 2 that did not participate in the research study.

²² In many other countries Life Sciences are called Biology at school level.

DBR is usually initiated and designed by the researcher, who is informed by participant input (Wang & Hannafin, 2005). This was also the case in this study. The participants' direct input was limited to their answers to the survey questionnaire and their input during the interviews. The participants had indirect input via the analysis of their VCoP messages. For example, the researcher posted a planned vignette about neuron function to Cycle 2. Not only did the discussion extend over a few days, but teachers corrected each other's misconceptions. The NCED official on the group, who had been very quiet for most of this cycle, also participated in this discussion. She not only assisted the researcher to point the discussions in the correct conceptual direction, but even offered and forwarded extra resources to any teacher who needed it. This gave the researcher positive input about teacher learning in Cycle 2.

4.5.1 The design process: planning the design, formative and retrospective, summative evaluation

In curriculum based topic specific DBR studies a hypothetical learning trajectory (HLT) is developed to guide the design step, and also to inform the retrospective and summative evaluation of the study (Bakker & Van Eerde, 2015). The term HLT originates from Simon (1995) who conceptualised it as consisting of three components. The first component consists of the learning goals that define the concept to be learned. The second component consists of the learning activities that will be used during the learning process. The third and last component is the hypothetical learning process, i.e. a prediction of the possible changes in learners' thought processes and understanding while they interact with the learning activities.

This DBR study is, however, not curriculum based topic specific, but aims to enhance the effectiveness of blended-learning TPL short courses, through WhatsApp support, across Natural and Life Sciences curricula. Effectiveness is measured against Guskey's (2002) five levels of professional development effectiveness. To incorporate this broader academic support focus, the term hypothetical support trajectory (HST) better suits this study. As for the three components, the HST comprises of the support goals, support activities and elements, and the hypothetical support process. The hypothetical support process is defined as a prediction of the main aim of the study, or more specifically for this study as a prediction of the enhancement of professional development effectiveness (Figure 4.9).

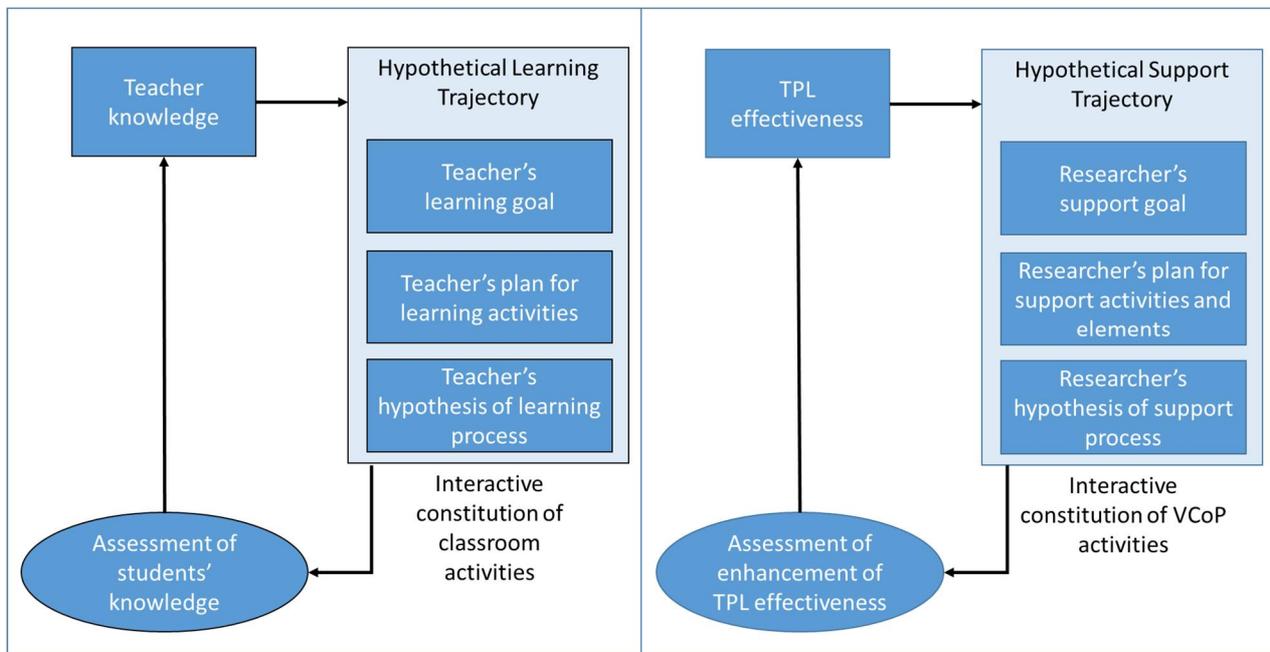


Figure 4.9: Diagrams comparing Simon's (1995) HLT within a mathematics teaching cycle with this study's HST within a design cycle.

4.5.1.1 Hypothetical Support Trajectory: the support goals

Each of the study's support goals links to a sub-research question (SRQ). Creating a functioning VCoP (support goal 1) links to SRQ 1: Which essential traits of a virtual community of practice (VCoP) were fostered in each WhatsApp VCoP? Supporting the initial satisfaction of teachers in the TPL courses (support goal 2) links to SRQ 2: In which ways did each WhatsApp VCoP support the initial satisfaction of teachers in the TPL courses? Support teacher learning in the TPL courses (support goal 3) links to SRQ 3: In which ways did each WhatsApp VCoP support teacher learning in the TPL courses? Enhance organisational support in the TPL courses (support goal 4) links to SRQ 4: In which ways did each WhatsApp VCoP provide organisational support in the TPL courses? Support teachers to implement new knowledge and skills, gained during the TPL courses, in classroom practice (support goal 5) links to SRQ 5: In which ways did each WhatsApp VCoP support teachers to implement new knowledge and skills, gained during the TPL courses, in classroom practice? And finally, support teachers to impact their learners' learning (support goal 6) links to SRQ 6: In which ways did each WhatsApp VCoP support TPL short course impact on learner performance?

4.5.1.2 Hypothetical Support Trajectory: process and support activities and elements

This study's theoretical and conceptual framework informed the TPL support model design and focussed the design within four main design outcomes:

1. A VCoP situated within a social media platform, creating
2. an environment that decreases transactional distance, and that
3. provides practice-based content that supports TPL students' course needs, leading to
4. enhanced TPL short course effectiveness.

The support activities or elements and the data collection and evaluation instruments were designed to complement these design outcomes. In the following sections the support activities or elements, linked to each design outcome, are described. Then the processes of data collection and data analysis are discussed.

4.5.1.3 Design outcome 1: A VCoP situated within a social media platform

Support activities or elements: For design outcome 1 the first support element was the social media platform decision. The choice of WhatsApp as virtual platform was based on South African teachers' access to WhatsApp and mobile phones, and the different perceived affordances of social media platforms (refer to Chapter 1, section 1.4 and Chapter 3, section 3.6.2). WhatsApp was therefore used as virtual platform for the VCoPs across all cycles.

4.5.1.4 Design outcome 2: An environment that decreases transactional distance

Support activities or elements: For design outcome 2 the researcher had to incorporate elements from transactional distance theory in the WhatsApp group discussions. Moore (1993; 2013) and Falloon (2011), focussing on instructor-learner interactions, argue that increased dialogue, increased student autonomy and looser activity structure lead to the lowest transactional distance, and therefore higher course satisfaction and improved learning outcomes. This is applicable to both distance and virtual teaching and learning environments. Pittenger (2013) compared three social network structured groups, focussing on their effectiveness for engaging inter-professional collaboration. He found that the minimally structured group was the least successful form of collaboration, whilst the highly structured group, though not a failure, did seem to inhibit student-initiated activity. Pittenger (2013) therefore recommended a facilitated group format. With the researcher's pilot study

(Ndlovu & Hanekom, 2014) a minimally structured group, as proposed by Moore (2013), but which Pittenger (2013) found to be the least successful, engaged well in inter-professional collaboration. An explanation for this could be that the participants in the pilot study taught in close proximity of each other and had already formed a social bond before joining the social platform group (Ndlovu & Hanekom, 2014). Because of the conflict between the researcher's findings in the pilot study and that of Pittenger (2013), different VCoP structures were assigned to each of the design cycles: minimally structured, facilitated and highly structured. To determine the order to be used in assigning the VCoP structuring, the researcher followed her literature review argument that teachers, as life-long learners, should be exposed to TPL courses at the intersection of the andragogic and heutagogic approaches. Therefore, Cycle 1 was assigned a minimally structured WhatsApp group that aligned with the heutagogical approach of self-determination. Cycle 2 was assigned the facilitated structured WhatsApp group that aligned with the andragogical approach of self-directedness. Informed by the formative evaluation of Cycles 1 and 2, the researcher added a third cycle (Cycle 3) and assigned to it a highly structured WhatsApp group that aligned with the pedagogical approach of lecture determination (Figure 4.10). The perception of the Wenger (1998) essential traits of learning through participation in a CoP had decreased from Cycle 1 to Cycle 2. The researcher needed to determine if a pedagogical approach would lead to a further decline, or to an increase in the perception of learning through participation in the CoP.

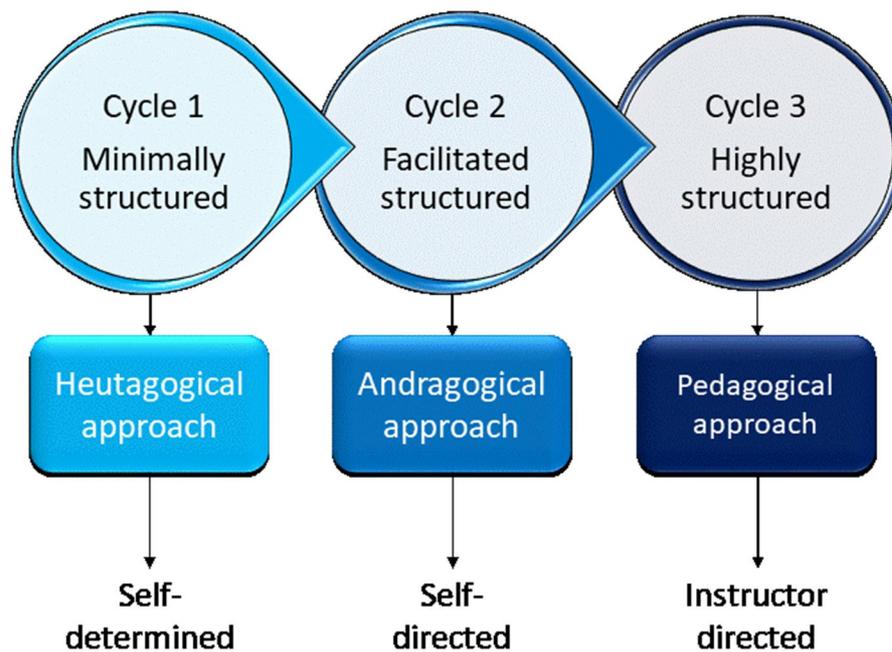


Figure 4.10: The VCoP structure for each design cycle.

In Cycle 1 participants could speak freely about any relevant TPL short course content. This was intermittently prompted by the researcher (as facilitator and as researcher) to ensure teaching presence and to engage participants. Participants were also free to post media that they felt could encourage their peers, e.g. quotes about teaching in general or birthday wishes. Between Friday afternoons and Monday mornings, the participants could freely engage socially, as long as the conversations included, or were aimed at, all participants.

In Cycle 2 the initial formative evaluation showed that more focus had to be placed on ensuring that domain-related issues were presented to the participants, and that issues that would encourage debate needed to be chosen. Domain-related issues speak to TSPCK, and participation through debate to teaching presence. In response, the researcher attempted to increase her teaching presence by regularly prompting the participants to share questions or problems that they encountered when teaching the TPL short course material. To enhance TSPCK related discussion, vignettes, material in response to participants' questions, or example exam questions that linked to the participants' questions, were posted to the group. Figure 4.11 shows a screenshot of an example of an exam question posted by the researcher.

Question 1

Assume that you breed with carrot plants and some produce purple carrots and others have orange carrots.



You conduct a series of crosses and obtain the following results:

	Progeny (First generation)	
	Purple	Orange
i) Purple x Orange	55	60
ii) Purple x Purple	36	0
iii) Orange x Orange	0	65
iv) Purple x Purple	92	30
v) Purple x Orange	44	0

💡 Let's think about this scenario 😊. Which colour do you think is the dominant colour? Just type "purple" or "orange".

09:48 ✓

Figure 4.11: Screenshot of example of an exam type questions.

A vignette is defined in the Collins Online English dictionary²³ as "a short description, picture, or piece of acting which expresses very clearly and neatly the typical characteristics of the thing that it represents." In this study vignettes are presented as short descriptions of, or pictures depicting, scientific concepts or processes. The use of vignettes follows from Finch's (1987) proposal to use vignettes to encourage debate and Bernabeo et al.'s (2013) finding that the use of vignettes could encourage a sense of professional community. The vignettes were posted to elicit responses from the participants and to engage them with the topics and with each other. Material to assist participants with the TPL short course concepts that they had struggled with during the contact session, was also posted. Participants in Cycle 2 were discouraged from posting any off-topic (overtly social) posts.

In Cycle 3, to support the predetermined highly structured format of the group, the researcher had to increase her teaching presence and TSPCK content even more. This decision was also informed by the initial formative evaluation that indicated that a more structured effort to encourage subject-topical knowledge debate was needed than in Cycle 2. The researcher therefore produced three types of posts, all linked to the TPL short course content:

(i) Vignettes or example exam questions were posted once a week to elicit responses from the participants and to engage the participants with the topics and with each other.

(ii) One short content explanatory video clip, with a question at the end, was posted once a week after the third contact session. Participants were expected to send their answers by private WhatsApp message to the researcher. This was done to give each participant a fair chance to attempt the question. At the end of the subsequent week, the researcher posted the correct answer on the group, along with the next video clip and new question. Participants were subsequently asked to comment on whether they were satisfied with the given answer. A twofold goal motivated the use of the video clips: to elicit engagement between participants, and to support participants with the most difficult topic in that TPL short course, namely balancing of chemical equations.

²³ <https://www.collinsdictionary.com/dictionary/english>

(iii) As part of the third TPL short course that took place during this cycle, participants attended an online practical content session via the web conferencing platform Adobe Connect. During this session a lecture was broadcasted from the SUNCEP offices in Stellenbosch to two venues that were relatively close to the participants' schools. The WhatsApp group not only served to relay logistical arrangements for the online session, but it served as discussion platform (during the broadcast) on which participants could share photos of their participation (Figure 4.12)²⁴ and on which they could share their thoughts and input.



Figure 4.12: Example of photo shared by participants during the Adobe Connect session. Participants in Cycle-3 were discouraged from posting any off-topic (overtly social) posts.

4.5.1.5 Design outcome 3: Practice-based content that supports and enhances TPL students' course needs.

In Cycle 1 practice-based content was shared through images, photos, YouTube videos, URLs to online content and discussion posts, at the request of participants.

In Cycle 2 practice-based content was shared in similar ways as in Cycle 1. Because WhatsApp had been upgraded, it was also possible to share content via documents at the request of participants.

²⁴ Names on WhatsApp messages blacked out on screenshots to ensure anonymity of participants. Each pseudonym starts with the Cycle number (e.g. C3 is Cycle 3), followed by the type of participant (e.g. Teacher) and a number that is linked to a particular participant in that cycle.

In Cycle 3 practice-based content was shared, as was the case in Cycle 1 and Cycle 2. It was enhanced with explanatory video clips that the researcher created specifically for this cycle, in response to a needs request by participants during their last contact session.

As practice-based content was included at the request of participants, this design outcome was deemed met and not specifically analysed further.

4.5.1.6 Design outcome 4: Enhanced TPL short course effectiveness.

The researcher needed to be able to evaluate whether any of the design cycles enhanced the effectiveness of the blended-learning TPL short courses they formed part of, and if so, which design principles within each model, showed optimal enhancement.

4.6 Data collection

This mixed method study collected both quantitative and qualitative data. In both quantitative and qualitative research data can be collected via planned instruments (Salkind, 2010). To ensure that a study can be duplicated by others, these instruments need to be described in detail.

4.6.1 Qualitative data collection

Qualitative data are usually collected through four basic procedures: qualitative observation, qualitative interviews, collection of qualitative documents and/or collection of qualitative audio and visual materials (Creswell, 2014).

4.6.1.1 Qualitative audio and visual materials

The largest set of data resulting from this study, were qualitative audio and visual materials in the format of narrative WhatsApp group messages. These messages, consisting of text and multimedia files, were downloaded from the researcher's smartphone to a computer by means of the WhatsApp application's 'Export chat' function. Screenshots were also taken of all the messages.

4.6.1.2 The semi-structured interview schedule (qualitative interview)

Zohrabi (2013) and Creswell (2014) describe qualitative interviews as a researcher and participants discussing topic related questions in f-2-f, telephonic or internet settings, in either a one-to-one or focus group scenario. Qualitative interviews can contribute to a more in-depth and nuanced understanding of survey data. This is one of the advantages of mixed method research (Creswell, 2014). A personal f-2-f or telephonic qualitative interview has

the potential advantage of overcoming the poor response rates often found with questionnaire surveys (Austin, 1981; Barriball & Alison, 1994) and is suitable for the investigation of motives, beliefs, attitudes and values (Barriball & Alison, 1994; King, Horrocks, & Brooks, 2018). In this study the qualitative interview was compiled to elicit views and opinions of participants in response to Guskey's (2002) five levels of determining the effectiveness of professional development programmes. The qualitative interview data was collected to triangulate with the WhatsApp message data.

Qualitative interviews can be structured, semi-structured or unstructured. Structured interviews have been described as verbally administered questionnaires that do not support in-depth data collection, as only limited participant responses are possible (Gill, Stewart, Treasure, & Chadwick, 2008). According to Barriball and Alison (1994), semi-structured interviews are well suited when the perceptions and opinions of participants, regarding intricate issues, are investigated. Semi-structured interviews also allow the researcher to probe for clarification of answers, something that is not possible with structured interviews (Barriball & Alison, 1994; Zohrabi, 2013). Another way to create flexibility is through unstructured interviews, but this format runs the risk of creating dissimilar and complex data, where all the topics the researcher wanted to probe might not be addressed equitably by all interviewees (Powney & Watts, 2018).

For this study a personal, semi-structured interview guide approach was followed. Interviewees were purposively chosen using criterion sampling²⁵. According to Patton (2015, p. 265) purposive sampling is defined as "strategically selecting information-rich cases to study, cases that by their nature and substance will illuminate the inquiry question being investigated." In each cycle the WhatsApp group participants were divided into high, medium or low participation criterion divisions, according to the number of messages they posted. In each of these criterion divisions four participants were invited to participate in the interviews.

Traditionally interviews are done in f-2-f settings which, when participants are geographically dispersed as the participants in this study were, can lead to a lot of time and money spent on travelling between interviewees (Opdenakker, 2006). Telephonic interviews extend

²⁵ Interview schedule can be viewed in Addendum D

access to these participants (Opdenakker, 2006) and with technological innovations, such as cellular phone call recorder applications, telephonic interviews can be recorded with ease. A contested aspect of telephonic interviews is the reduction of social cues, which Hermanowicz (2002) and Shuy (2003) argue to be a disadvantage. Proponents, such as Chapple (1999) and Novick (2008), argue reduction of social cues to be an advantage, as interpreting body language during f-2-f interviews are subjective, can be distracting to the interviewer and negatively influence the interview outcome. Trier-Bieniek (2012) further proposes that reduced visual cues compel both interviewee and interviewer to listen more attentively to each other, increasing understanding for both parties. In this study the semi-structured interview was e-mailed to participants who agreed to be interviewed beforehand. Interviews were scheduled to accommodate both interviewer and interviewee schedules, as suggested by Burke and Miller (2001). Interviewees were reminded at the start of the telephonic conversation that the interview was being recorded and that anonymity would be assured by use of designated pseudonyms during transcription. All interviews were recorded using the free Android Call Recorder²⁶ application.

4.6.2 Quantitative data collection

Quantitative data are usually collected through two basic procedures: surveys or experimental procedures (Creswell, 2014).

4.6.2.1 The VCoP validation questionnaire (survey)

Before assessing the success of each of the cycles to support TPL short courses, the researcher had to be sure that a valid VCoP was formed in each cycle. According to Creswell (2014) a survey instrument, e.g. a questionnaire, provides the researcher a quantitative portrayal of opinions, trends or attitudes of a population. Quantitative survey instruments have a compact design, leading to a rapid data collection turnaround time (Creswell, 2014). This feature makes it a useful tool for the formative evaluation of the cycles within this DBR study. Survey data cannot always provide the in-depth details required for a topic being investigated (Kelley, Clark, Brown, & Sitzia, 2003). However, the survey employed in this study produced enough data to inform the formative evaluation of the cycles. Murillo (2008) developed a mainly quantitative, validated survey instrument that

²⁶ <https://play.google.com/store/apps/details?id=call.recorder.automatic.acr>

can be used to determine the validity of VCoPs by testing for the presence of essential traits. The essential traits of a VCoP refer to Wenger's (1998) five CoP constructs, which, when present in an online group, conclusively validate the existence of a VCoP. Murillo (2008) linked four of these exemplary traits to nine factor-analysis-validated scales (Figure 4.13), which was then used to construct a VCoP validation questionnaire. Murillo (2008) added one qualitative question that linked to the fifth Wenger construct.

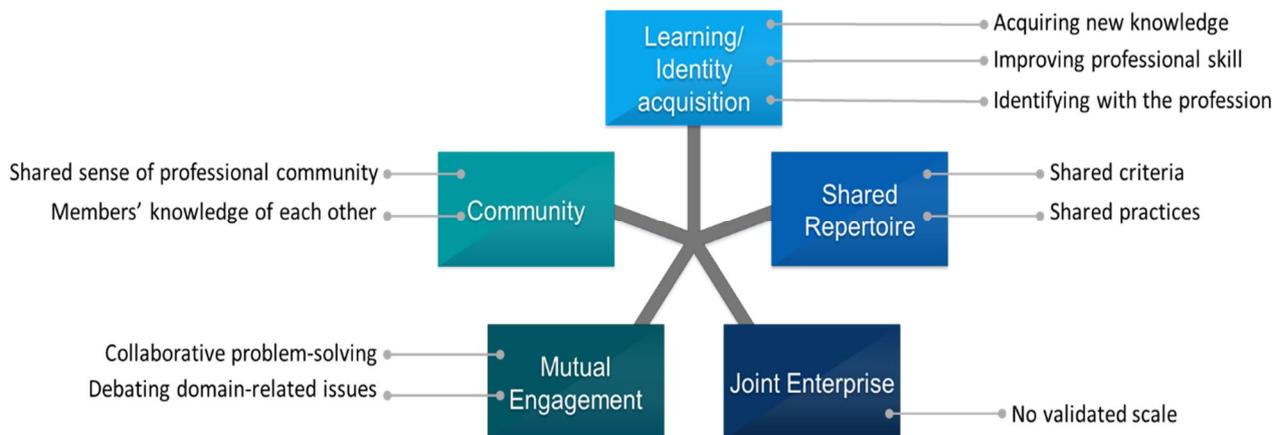


Figure 4.13: Wenger's (1998) five constructs with Murillo's (2008) nine factor-analysis-validated scales.

To formally assess the validity of each build cycle as a VCoP, the researcher requested and received permission from Dr Murillo to use his 2008 survey instrument. There were two advantages to using this published questionnaire. The questionnaire was double validated by Murillo (2008), which negated the need to first pilot a newly developed questionnaire. Secondly, because Murillo's (2008) questionnaire is a quantitative instrument, it negates the usual time intensive qualitative analysis of VCoPs, used to determine the presence of all five essential traits. The VCoP validation questionnaire was used to collect data from each cycle to formatively evaluate whether each of the Whatsapp groups in each cycle was a valid VCoP. It was then used to retrospectively analyse all three cycles to determine the relative effectiveness of each cycle as a VCoP. A slight adaption of wording in the questionnaire was made to address the difference in context. Murillo's (2008) survey was aimed at newsgroup VCoPs, whereas this study is aimed at teacher professional learning (TPL) VCoPs (see Addendum C).

The validation questionnaire consisted of 35 quantitative Likert scale items (a five-point, ordered, one-dimensional scale), one qualitative textual item and five demographic items. The respondents were required to choose one option from each Likert scale item that best aligned with their viewpoint on the corresponding statement. To assist respondents, a visual

scale was used, where each scale point was represented by a different emoticon (Figure 4.14).



Figure 4.14: Example of one item on the Likert scale used in the online questionnaire.

Wenger's first essential trait (Trait 1) refers to learning through participation in a community of practice (CoP). In this study CoP is extended to refer to a virtual community of practice (VCoP). The second essential trait (Trait 2) is member interaction within the VCoP and the third essential trait (Trait 3) the use of group specific tools and standards in the VCoP. In this study the group specific tools and standards refer to the use of WhatsApp and educational specific tools and standards. Essential trait four (Trait 4) is the presence of a sense of community in the VCoP. A single qualitative question mapped to the fifth Wenger (1998) essential trait (Trait 5), namely caring for a domain of knowledge. The domain of knowledge refers to the joint enterprise of the group. In this study the joint enterprise is the teaching of science, which includes the practice of teaching, as well as the conceptual understanding of science.

Murillo (2008) assigned sub-themes to each essential trait. For Trait 1, learning through participation in a VCoP, he assigned three sub-themes: improving professional skills in the VCoP (sub-theme 1A), acquiring new knowledge in the VCoP (sub-theme 1B) and identifying with the profession in the VCoP (sub-theme 1C). Murillo (2008) assigned two sub-themes to each of Traits 2 to 4. Member interaction within the VCoP (Trait 2) was mapped to collective problem solving in the VCoP (sub-theme 2A) and debating of domain-related issues in the VCoP (sub-theme 2B). Shared criteria in the VCoP (sub-theme 3A) and shared practices in the VCoP (sub-theme 3B) were assigned to the use of group specific tools and standards in the VCoP (Trait 3). The two sub-themes for the presence of a sense of community in the VCoP (Trait 4) were shared sense of professional community in the VCoP (sub-theme 4A) and members' knowledge of each other in the VCoP (sub-theme 4B). The data were collected after each of the cycles via Stellenbosch University's SUNSurvey

platform²⁷. Figure 4.15 gives a diagrammatic summary of the build steps' data collection events.

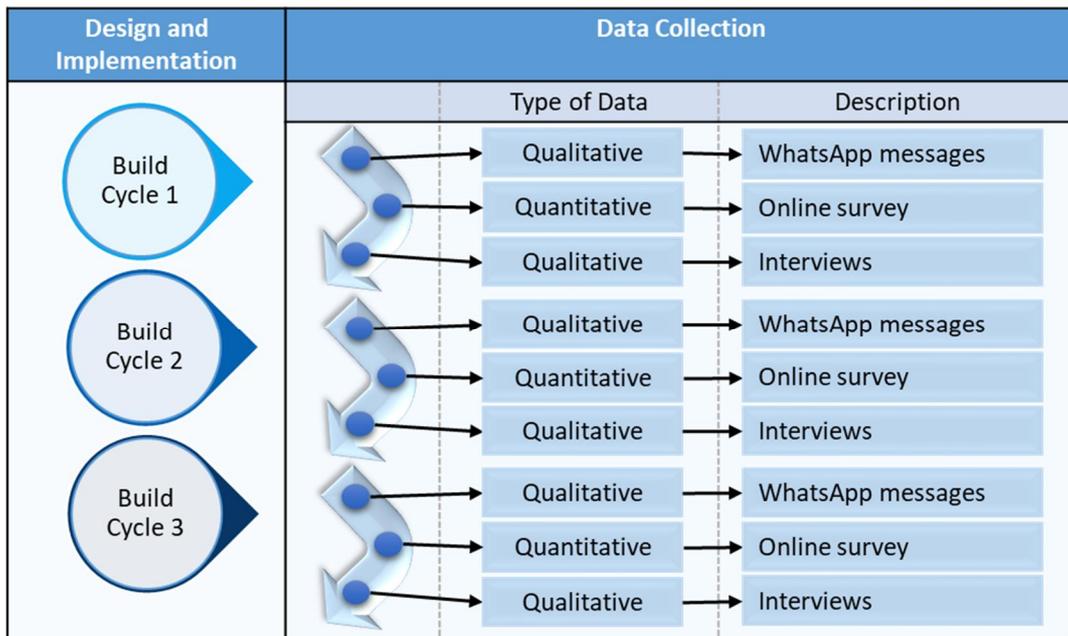


Figure 4.15: Diagrammatic overview of the three iterative cycles' data collection events.

4.6.3 Reliability, validity and trustworthiness of data collection instruments

In mixed method research, the different ways of gathering information via both quantitative and qualitative methods, boosts validity and reliability or trustworthiness of the data collected (Zohrabi, 2013). Caution must be taken as to the explicit meaning of the terms validity and reliability, as researchers differ in their interpretation of the terms within the two methods. In essence, however, validity of an instrument asks whether an instrument measures what it purports to measure and reliability focusses on replicating results, irrespective of by whom or when an instrument is used (Creswell & Plano Clark, 2011; Zohrabi, 2013). In an attempt to address the issues that qualitative researchers have with these concepts within qualitative research, Lincoln and Guba (1985) reconceptualised some of the traditional quantitative concepts, linking them to new, more acceptable, qualitative dimensions (Table 4.3).

²⁷ <https://sunsurveys.sun.ac.za> (password protected site). Questionnaire can be viewed in Addendum C

Table 4.3:

Comparing quantitative research concepts with Lincoln and Guba's (1985) qualitative dimensions.

Quantitative research concept	Qualitative research dimensions of trustworthiness
Internal validity	Credibility
External validity	Transferability
Reliability	Dependability
Objectivity	Confirmability

Lincoln and Guba (1985) combine the quantitative concepts of validity and reliability in one qualitative concept: trustworthiness. In quantitative research, instruments are measured for validity and reliability, through statistical methods (Creswell & Plano Clark, 2011; Tavakol & Dennick, 2011). In qualitative research, trustworthiness cannot be measured via statistical methods, but the trustworthiness of a study can be strengthened through triangulation of the data (Creswell & Plano Clark, 2011; Zohrabi, 2013).

4.6.3.1 The reliability and validity of the VCoP validation questionnaire

The survey instrument was originally validated for internal and external consistency by Murillo (2008). Some of the wording were changed to suit the context of this study. Cronbach's alpha (α) was therefore used to measure the internal consistency of the survey instrument and to ensure that it was not affected by the changes (George & Mallery, 2003; Iacobucci & Duhachek, 2003; Tavakol & Dennick, 2011). Cronbach (1951) describes alpha as a reliability coefficient to provide researchers with a way to measure the inter-relatedness of items of a quantitative test on a scale between 0 and 1, with alpha values closer to 1.0 indicating greater internal consistency of the test items. George and Mallery (2003) provide Cronbach's alpha interpretation guidelines (Table 4.4).

Table 4.4:

Cronbach's alpha interpretation guidelines (George & Mallery, 2003)

Cronbach's alpha	Internal consistency
$\alpha \geq .9$	Excellent
$.9 > \alpha \geq .8$	Good
$.8 > \alpha \geq .7$	Acceptable
$.7 > \alpha \geq .6$	Questionable
$.6 > \alpha \geq .5$	Poor
$.5 > \alpha$	Unacceptable

The Cronbach alpha reliability coefficient for the 35 items in the questionnaire was determined for data from each cycle using the Reliability Calculator Excel spreadsheet developed by Del Siegle²⁸. After Cycle 1, 12 of the 38 (31.6%) WhatsApp group participants responded to the survey instrument. After Cycle 2, 12 of 29 (41.4%) participants responded and after Cycle 3, 8 of 15 (53.3%) participants responded. In Cycle 1 the overall Cronbach alpha is 0.976. In Cycle 2 it is 0.983 and in Cycle 3 it is 0.970. As the instrument is divided into 4 subscales, according to Essential Trait themes, Cronbach alpha was also determined for each of these subscales in each cycle (Table 4.5).

Table 4.5:

The VCoP validation survey instrument completion rate and Cronbach alpha for each cycle and its sub-scales.

	Cycle with sub-scales	Items per sub-scale	Surveys completed (%)	Cronbach alpha per subscale	Cronbach alpha overall
1	Trait 1	11	26.3	0.969	0.976
	Trait 2	7		0.914	
	Trait 3	7		0.814	
	Trait 4	10		0.914	
2	Trait 1	11	41.4	0.977	0.983
	Trait 2	7		0.953	
	Trait 3	7		0.972	
	Trait 4	10		0.970	
3	Trait 1	11	53.3	0.960	0.970
	Trait 2	7		0.753	
	Trait 3	7		0.878	
	Trait 4	10		0.909	

According to George and Mallery (2003, p. 231) an $\alpha \geq 0.9$ can be interpreted as excellent, $0.9 > \alpha \geq 0.8$ as good and $0.8 > \alpha \geq 0.7$ as acceptable. All the sub-scales had an $\alpha > 0.7$, and the overall $\alpha > 0.9$. Tavakol and Dennick (2011) suggest that $\alpha > 0.90$ implies redundancies, but the researcher chose, for the sake of reliability, to keep the survey as close to Murillo's (2008) original survey as possible, making only contextual adaptations. The sample sizes are very small, but Iacobucci and Duhachek (2003) showed that Cronbach

²⁸ <https://researchbasics.education.uconn.edu/excel-spreadsheet-to-calculate-instrument-reliability-estimates/>

alpha values are robust, even for small samples, except in extreme situations, for example where there are only two items or r approaches 0.

4.6.3.2 The trustworthiness of the semi-structured interview schedule

To strengthen the trustworthiness of this study, the interview instrument data was triangulated with both the quantitative survey data and the qualitative WhatsApp message narrative data.

4.7 Data analysis

As both qualitative and quantitative data were collected for this study, decisions had to be made on both the qualitative and quantitative data analysis procedures to be used.

4.7.1 Quantitative data analysis

The quantitative data collected via the VCoP validation questionnaire was quantitatively analysed, both for the formative evaluation of each cycle and for the two retrospective evaluations of the study. The quantitative data set from the Likert scale survey consisted of univariate data. Univariate data refers to quantitative data where a single dependent variable, in this study percentage of respondents, are described with relation to the attributes, for example the different Likert scales (Babbie, 2009). As a first step, the data were organised into frequency distribution tables. A screenshot of part of the frequency distribution table from Cycle 1 can be seen in Figure 4.16.

	A	B	C	D	E	F	G	H	I	J
1	Survey: Instrument to validate formation of a Community of Practice.									
2										
3	Part 1: Learning through participation in the CoP				SD	D	N	A	SA	CHECK
4	Improving professional skills	Participation in this WhatsApp group has improved my teaching skills.		1,5	1	0	6	5	0	12
5		Participation in this WhatsApp group has raised the level of professionalism I hold myself to.		1,10	0	1	6	5	0	12
6		Participation in this WhatsApp group has improved my teaching attitude.		1,1	1	0	3	8	0	12
7		Participation in this WhatsApp group has improved my teaching style.		1,9	1	0	5	6	0	12
8		AVERAGE			0,75	0,25	5,00	6,00	0	
9	Percentage			6%	2%	42%	50%	0%		
10	Acquiring new knowledge	Participation in this WhatsApp group has increased my content knowledge of the subject.		1,3	1	0	4	7	0	12
11		Participation in this WhatsApp group has increased my pedagogical knowledge of the subject.		1,6	1	0	6	5	0	12
12		Participation in this WhatsApp group has increased my understanding of teaching the subject.		1,11	1	0	4	7	0	12
13		AVERAGE			1		4,667	6,333	0	
14		Percentage			8%	0%	39%	53%	0%	
15			On a professional level I could strongly identify with the members of this WhatsApp group.	1,4	1	0	6	5	0	12

Figure 4.16: Screenshot of part of the frequency distribution table from Cycle 1.

Frequency distribution graphs were then drawn, as Babbie (2009) and Manikandan (2011) propose that frequency distribution graphs, as diagrammatic illustrations, give both the researcher and the reader a more accessible glance into the data than frequency tables. These frequency distribution graphs, and interpretation of the data, can be found in Chapter 5.

4.7.2 Qualitative data analysis

Madill and Gough (2008, p. 254) describe the approaches of qualitative analysis to be "best conceptualized as a fuzzy set". Researchers therefore have a daunting task in choosing an approach. They also need to explicitly describe their process, to not only produce an audit trail, but also to guide the reader on how the findings, interpretations and subsequent conclusions were derived from the raw data. To choose an analytical approach for the qualitative part of this mixed method study, the researcher was informed by the epistemology and methodology, the proposed design outcomes of the study, the type of research questions, as well as the kind of qualitative data collected. The chosen approach therefore had to fit a pragmatic paradigm, DBR outcomes and evaluative and strategic research questions, while providing a systematic procedure for dealing with a large volume of data. During the 1980s, Ritchie and Spencer (1994) specifically developed the framework analysis approach for applied research contexts. It is a highly structured procedure, not aligned to a particular epistemological or theoretical approach, for processing the analysis of large volumes of data that lead to "actionable outcomes" (Ritchie & Spencer, 1994, p. 173). As DBR is an applied research type that produces large volumes of data and that focusses both on evaluation and theory building, framework analysis was seen as a potential fit. Framework analysis is seen as a highly structured, systematic version of the thematic analysis approach (Gale, Heath, Cameron, Rashid, & Redwood, 2013). It supports a hybrid approach of both deductive, *a priori* theory driven, and inductive, emergent data driven, development of the analytic framework (Gale et al., 2013; Parkinson, Eatough, Holmes, Stapley, & Midgley, 2016). These characteristics of framework analysis fit the aims of this study, as the different research questions are theory driven, but the researcher wanted to remain open to emergent codes and themes. The highly structured and systematic approach also ensures analytic rigour. As for this study's research questions, they fit two of the four types of research questions that Ritchie and Spencer (1994) suggested could be successfully analysed via framework analysis. The two concurring types are evaluative questions, which appraise effectiveness and strategic questions, which identify new

theories, policies, plans or actions (Parkinson et al., 2016; Ritchie & Spencer, 1994). The researcher therefore deemed the framework analysis approach as the most suitable qualitative analysis strategy for this study. For the retrospective evaluation of the study, the single qualitative answer data from the VCoP validation questionnaire, the qualitative data collected via the semi-structured interview schedule (transcribed interviews), as well as the narrative WhatsApp messages, were qualitatively analysed using thematic framework analysis (Ritchie & Spencer, 1994; Spencer, Ritchie, & O'Connor, 2014) (see Chapter 6).

Ritchie and Spencer's (1994) five stages of framework analysis are: familiarisation, identifying a framework, indexing, charting and mapping, and interpretation. These stages are presented in a linear format in the following sections. However, especially within a DBR study, they play out in an ongoing back-and-forth movement between stages. In the retrospective analyses the *a priori* codes and categories were derived from Guskey's (2002) five levels of determining the effectiveness of professional development programmes, which informed sub-research questions 2 to 6. In the qualitative results chapter (Chapter 6) only the interpretation stage, linked to a specific sub-research question's theoretical framework, will be highlighted. The stage descriptions will not be repeated.

4.7.2.1 Familiarisation

In most qualitative analysis approaches this stage is referred to as "immersion". The researcher aims to get a feel for the data; from the individual data sources, such as interviews, to the overall, holistic picture presented by all the data (Ritchie & Spencer, 1994). In this study it involved reading the WhatsApp group discussions, re-listening to the interviews while reading the transcripts, and noting any emerging concepts. According to Srivastava and Thomson (2009) not all the material need to be reviewed, as this will happen as the stages progress. Re-listening to the interviews, while reading the transcripts, reminded the researcher of the emotional atmosphere of each interview, while reconnecting her to the different build cycle groups' context and mood. This was a very positive experience, as in some cases a build cycle had transpired two to three years before the retrospective analysis event.

4.7.2.2 Identifying the analytical framework

The analytical framework consists of categories, codes and sub-codes that will be used to index (code) the data in the next stage (Parkinson et al., 2016). These categories, codes and sub-codes can either be identified inductively, through open-coding of data and general

thematic analysis, deductively from the research questions and their theoretical framework, or through a hybrid of the two approaches (Gale et al., 2013; Parkinson et al., 2016; Ward, Furber, Tierney, & Swallow, 2013). Within qualitative research, different meanings are attached to the concepts related to coding (Bradley, Curry, & Devers, 2007; Gale et al., 2013; Janesick, 2003). To ensure rigour, the researcher therefore had to clarify these concepts within the context of this study. Framework categories are often referred to as thematic categories, e.g. Wood et al (2010), creating the misconception that these categories are similar to analytic themes (Parkinson et al., 2016). However, especially where a deductive or hybrid analysis approach is used, framework categories are usually clusters of codes formed around interrelated or similar theoretical concepts (Gale et al., 2013). In this section of the study, ten categories were initially derived from Guskey's (2002) five levels of determining the effectiveness of professional development programmes, by dividing each of the five levels into their positive and negative perspectives. The next step was to assign *a priori* codes to each category. According to Saldaña (2015, p. 4) codes are defined as "...a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data". Within the framework categories, using Guskey's (2002) level descriptors for each category, the *a priori* codes were developed (Figure 4.17).

Sub-Research Question 2
In which ways did each WhatsApp VCoP build step support the initial satisfaction of teachers in the TPL programmes?

Guskey (2002) Level 1¹: Were the participants satisfied with the experience?

Category	Abbrev.	Category descriptions	Codes	Example
Participants' reaction	GL_1:PR	Student states or alludes to satisfaction with:		
		* the logistics (time well spent)	#logistics	
		* content choice (useful/made sense/well planned)	#content choice	
		* perceived facilitator's knowledgeability	#knowledgeability	

Figure 4.17: Extract from the initial analytical framework.

The researcher then coded the WhatsApp group messages of Cycle 1 within the qualitative data analysis software (QDAS) package, Atlas.ti 8, to test the analytical framework. As proposed by Spencer, Ritchie and O'Connor (2014), this was not a once-off, linear process,

but a backwards and forwards process between the framework's codes and the data, to rethink and rework the codes: expanding, splitting, combining, or even adding new codes emerging from the data, or refining of the descriptions of codes. Beside conceptual type codes (starting with #), participant characteristics and setting codes, as described by Bradley et al. (2007), was added to the analytic framework as sub-codes (starting with ##). Examples of quotations, the term used by Atlas.ti to define the strings of words or images to which codes are attached, were also added to the analytical framework (Figure 4.18).

Guskey (2002) Level 1⁵: Were the participants satisfied with the experience? Where experience is linked to

- the participants' reaction to the use of the WhatsApp group [##Comments abt WA] within the TPL group (on WhatsApp group [##WA] and in interviews [##INT]).

Category	Abbrev.	Description of code	Code	Example
Participants' reaction	GL_1PR	Student states or alludes to satisfaction with:		
		* the logistics (time well spent)	#logistics	<ul style="list-style-type: none"> " I think we must thank you again for all your support, quick responses and good communication! ! Op jul kop [You've done good]! !
		* content choice (useful/made sense/well planned)	#content choice	<ul style="list-style-type: none"> "This session was something else. Learned alot. Very interesting."
		* language ⁶ use	#language	<ul style="list-style-type: none"> "Excellent .I like your comment!" (<i>In response to request to use English only in group</i>)
		* perceived facilitator's knowledgeability	#knowledgeability	<ul style="list-style-type: none"> "To the presenters, a job well done. 🍀 "

Figure 4.18 Extract from the analytical framework before the indexing stage.

Only once clarity about each code and category is found and no more new codes emerge from the data sample, can the analytical framework be deemed fit to use on all the data (Spencer et al., 2014). The analytical framework is, however, still a work in progress and is actually never completed "until the last transcript has been coded" (Gale et al., 2013, p. 5). Therefore, before the researcher moved on to the indexing stage, the Cycle 1 WhatsApp group messages were repeatedly coded until no new codes emerged.

4.7.2.3 Indexing

The purpose of indexing is to organise the data according to the framework categories (Ritchie & Spencer, 1994), or in other words to systematically code each data set with codes and categories from the analytical framework (Parkinson et al., 2016). The WhatsApp group messages from Cycles 1 to 3, the interviews from each of the three cycles and the qualitative

data from the VCoP validation questionnaire were therefore indexed during this stage using Atlas.ti 8 (Figure 4.19).



Figure 4.19: Screenshot from Atlas.ti 8 showing quotations and codes.

Once again, as suggested by Spencer, Ritchie and O'Connor (2014) and Parkinson et al. (2016), this was not a once-off, linear process, but a backwards and forward process between the analytical framework's codes and the data. During this process more codes and sub-codes emerged from the data and these were added to the analytical framework. All the data sets were re-coded when a code or sub-code was added. Only once no new codes emerged did the researcher move on to the charting stage.

4.7.2.4 Charting

Charting refers to the summarising of the coded (indexed) data by categories and codes, using a matrix format (Gale et al., 2013; Parkinson et al., 2016; Ritchie & Spencer, 1994). This can be done by hand (e.g. pen and paper), by using spreadsheet software (e.g. Microsoft Excel²⁹) or a QDAS package (e.g. NVivo, which has charting capabilities) (Parkinson et al., 2016). Atlas.ti 8 does not have charting capabilities yet, but it is easy to filter quotations by different codes and/or categories via its Analysis Query Tool. With the Query Tool a search expression can be built from operands (codes and categories) and Boolean operators (e.g. NOT, AND, OR, etc.) that define the conditions that quotations must meet to be included in the query result. An example is shown in Figure 4.20 where a query was raised for all the quotations that were coded for the following: sub-category 'Guskey

²⁹ From here on the term Excel will be used to enhance readability.

Level 1: positive participant reaction' (GL_1:PR), the code 'logistics' (#logistics) and the sub-code 'comments about the use of the WhatsApp group' (#Comment abt WA).

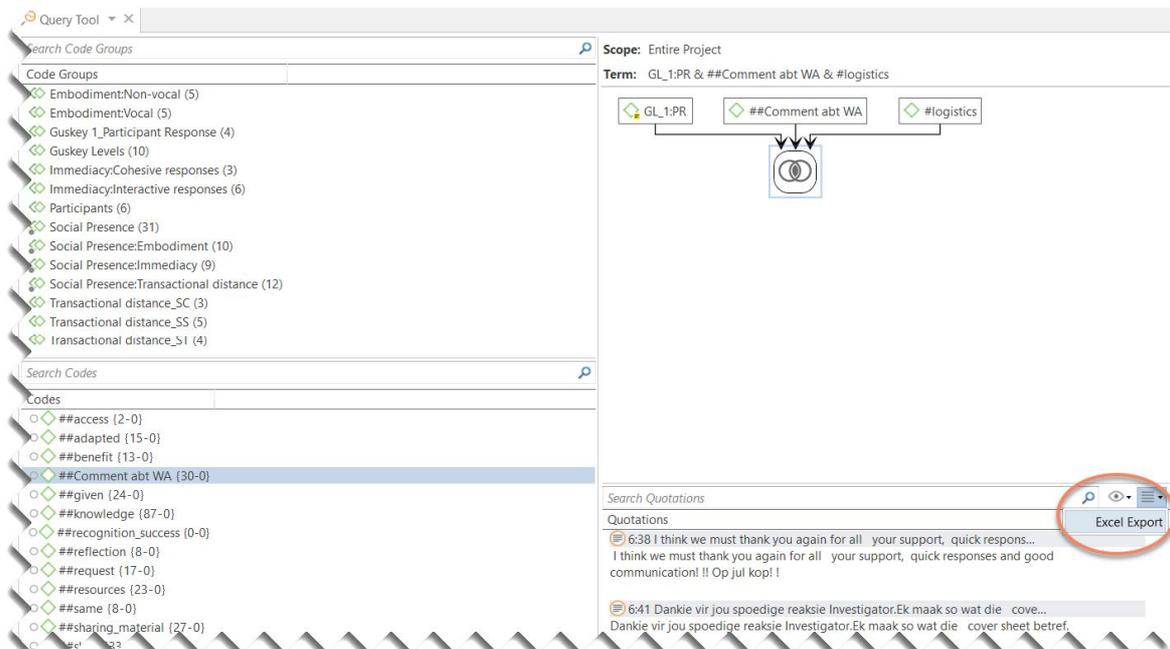


Figure 4.20: Screenshot of Atlas.ti, showing the Query Tool and export option (red circle).

The results of any query can be exported to Excel (Figure 4.21).

	A	B	C	D
1	ID	Document	Quotation Content	Codes
2	6:41	WhatsAppgroup Messages_NS_Cycle1_2015	Dankie vir jou spoedige reaksie Researcher.Ek maak so wat die cover sheet betref. [Thank you for the speedy reaction, Researcher. I will follow your request about the cover sheet]	##Stu ##Comment abt WA #logistics GL_1:PR C1_Teacher 09
3	6:38	WhatsAppgroup Messages_NS_Cycle1_2015	I think we must thank you again for all your support, quick responses and good communication!! Op jul kop!! [Well done]	##Stu ##Comment abt WA #logistics GL_1:PR C1_Teacher 10
4	6:206	WhatsAppgroup Messages_NS_Cycle1_2015	students take photo on WA as roll-call	##Stu ##Comment abt WA #logistics #telematic session GL_1:PR C1_Teacher 10
	8:16	Interviews_Teacher16_NS_Cycle1_2015	En julle was redelik...uhm...vinnig...op...op die punt af om te help...uhm...en vinnig op die punt af om	##Stu ##Comment abt WA

Figure 4.21: Screenshot of excerpt of exported Excel sheet from Atlas.ti 8 query.

A charting matrix usually comprises of one column per code and one row per participant or theme (Ritchie & Spencer, 1994). One Excel sheet is usually allocated to each category (Gale et al., 2013). The information in the exported Excel spreadsheets of this study were used to populate the sheets within the charting matrix. As described by Ritchie and Spencer

(1994) and Gale et al. (2013), this is not simply a copy and paste process, but an abstraction, inserting summaries into corresponding cells in the charting matrix (Gale et al., 2013). For this study the charting matrix was originally set out as per Gale et al. (2013). During the coding phase the categories had also been subdivided into sub-categories, as the need arose. More detail about the sub-categories are given in the interpretation sections in Chapter 6. Each sub-category was linked to one Excel sheet. The adapted charting matrix comprised of the participants in rows, and the columns that were allocated to the quotes and summaries (emerging/possible themes) (Figure 4.22).

A	B	C	D	E	F	G	H
1	6.43 Gr1_WhatsAppGroup Messages_NS_Cycle 1_2015	Superstar	##Stu #Comment abt WA #logistics GL_1:PR Teacher 16			general logistics : Refers to participants demonstrating their general satisfaction with use of WA	
2	6.74 Gr1_WhatsAppGroup Messages_NS_Cycle 1_2015	image with tablets	##Stu #Comment abt WA #ICT #logistics #Res GL_1:PR			WA communication of logistics : Refers to participants demonstrating their satisfaction with how logistics were communicated via WA	
3	6.41 Gr1_WhatsAppGroup Messages_NS_Cycle 1_2015	Dankie vir jou spoedige reaksie Investigator.Ek maak so wat die cover sheet betref.	##Stu #Comment abt WA #logistics GL_1:PR Teacher 9			WA communication between students : Refers to participants demonstrating their satisfaction with being able to communicate with each other via WA	
4	6.38 Gr1_WhatsAppGroup Messages_NS_Cycle 1_2015	I think we must thank you again for all your support, quick responses and good communication!! Op jul kop!!	##Stu #Comment abt WA #logistics				
10	her13_NS_Cycle1_2015	meen...uhm...ok dit was nou...hoe jy dan nou ook met ander kollegas vinnig inverbinding kon tree	#Comment abt WA #INT #logistics GL_1:PR				
11	11:6 Gr1_Interviews_Teach her13_NS_Cycle1_2015	Ja, dit was nogal flink en vinnig en...ek meen...en al was jy nou...soos byvoorbeeld jy werk saam met jou klas en jy kon vinnig iets deel en ander mense kon ook sien en dan sit ander ook weer byvoorbeeld aangespoor...so vir my was dit flink...ja vinnig...en dit was doeltreffend	##Stu ##WA #Comment abt WA #INT #logistics GL_1:PR				
11	14:1 Gr1_Interviews_Teach her14_NS_Cycle1_2015	Man die WhatsApp groep is eintlik 'n goeie ding jy weet, want...uhm...as jy nou kom en jy sekere probleme...sekere vraiges het...uhm...jy weet dan is dit 'n baie goue manier om 'n antwoord te kry. En jy weet mense kan 'n goedkoper...uhm...op 'n goedkoper manier met mekaar gesels, al	##Stu ##WA #Comment abt WA #INT #logistics				

Figure 4.22: Screenshot of an excerpt of one sheet of the charting matrix used in this study.

To ensure rigour at all times, the researcher moved back and forth between the charting matrix and the original quotes in their context on Atlas.ti 8. One of the advantages of using the queries and the charting matrix is that the researcher could, at all times, see which categories or codes had not been summarised yet (Gale et al., 2013). After charting all the data in this way, the researcher moved on to the final stage of framework analysis, namely mapping and interpretation.

4.7.2.5 Mapping and interpretation

Parkinson et al. (2016) refer to stage one to four of framework analysis as the data management stages. The fifth stage of framework analysis they refer to as the sense-making stage. This is where the researcher has to focus on finding patterns, and communicating her own sense-making of the data, informed by the study's research

questions. Ritchie and Spencer (1994) suggest that mapping and interpretation should include concept explanations and the representation of the nature and range of emerging themes within the data, thereby creating typologies and highlighting relationships between the themes. This could lead to researcher proposed strategies or design concepts, in other words theory building. From the charting matrices, the researcher created summarised mapping matrices.

4.7.2.6 Mapping the data

As suggested by Gale et al. (2013), the first mapping matrix compiled by the researcher comprised of the codes in rows, and the columns allocated to the summaries (emerging/possible themes) containing exemplar quotes. The researcher realised that context and meaning often seemed lost in the mapping matrix, because the data consisted of both interviews and WhatsApp message data. To alleviate this problem, timeframe context tick-off columns, linking to the chosen quote in each summary, were added to the mapping matrix. The final mapping matrix comprised of the codes in rows, with the columns allocated to a participant summary column, the context columns, the summaries (with exemplar quotes), emerging themes, and a researcher memo column. All Atlas.ti 8 ID numbers of quotes were added to the sub-category summary column, as well as at least one full exemplary quote per summary. (Figure 4.23).

A	B	C	D	E	F	G	H	I	J	
Build Cycle 1		CONTEXT timeframe quote was made * timeframe quote refers to ^				CATEGORY WITH SUMMARIES AND QUOTES		EMERGING THEMES	MEMOs	
1	CODES	group participant/s	Before contact session	During or at end of contact sessions	Between contact sessions	During or at end of telematic sessions	After end of course, near end of cycle	WhatsApp [WA] participant's reaction to the use of the WA group within TPL programme (on WA or in interview (INT))		
2	#logistics	Teachers: 16, 6, 14					6:43, 10:5 (INT), 14.1 (INT) General satisfaction about use, different kinds of info can be shared via WA messages Ja-nee, dit het beslis my behoeftes en belange ondersteun. [Yes, it definitely supported my needs and interests] [10:5 - T6]	general logistics : Refers to participants demonstrating their general satisfaction with use of WA		
3		Teachers: 6, 13, 14	*^				10:2 (INT), 11:1 (INT), 11:6 (INT), 14:1 (INT) info can be shared between students via WA messages ...ek kon van my kant of belangrike inligting deurgee of 'n idee wat ek het kon ek deurgee... [From my side I could share important information or I could share an idea that I had another thing...[10:2 - T6] ...soo by myself ek was net soos 'n ja-nee kon in my eie dade... for	WA communication between students : Refers to participants demonstrating their satisfaction with being able to communicate with each other via WA	Reasons why satisfied: communication is fast, effective and cheap way to share information	
5	#content choice	Teacher 6, 46, 3	*^		*^		...in my eie dade... images: telematic roll-call (6:206 - T10) 10:8 (INT), 9:6 (INT) Teachers were exposed to material and skills that supported the curriculum and were relevant. ...die kursus was baie ryk aan inhoud...uhm...praktiese aktiwiteite...dit het regtigwaar dit wat voorgeskryf was in die KABV dit het dit regtigwaar gesteun. (10:8 - T6) The WhatsApp group formed part of ICT skills training. kind of integrating with the ICT skills and that is what is mostly needed in the teaching know (13:2 - T3) 13:4 (INT)	curriculum content : Refers to participants demonstrate their satisfaction with course content, posted on WA group, aligning to the curriculum.	reasons why satisfied: relevance and ICT integration skills	
6		Teacher: 14						general content : Refers to		

Figure 4.23: Screenshot of an excerpt of one sheet of the mapping matrix used in this study³⁰.

³⁰ Addendum E has a full sheet example where each abbreviation used is explained.

Once all the sub-category mapping matrices were compiled for each cycle, the researcher could move on to the interpreting stage of this phase.

4.7.2.7 Interpreting the data

The mapping matrixes for the different sub-categories were used to compare themes within, and across, cycles. During the interpretation phase, all interpretations were cross-checked between the mapping matrices and the original data to enhance rigour (Parkinson et al., 2016; Ritchie & Spencer, 1994; Ward et al., 2013). The researcher's interpretation of the data, flowing from the described framework analysis process, and linked to each of sub-research questions 2 to 6, are presented in Chapter 6.

Figure 4.24 gives a diagrammatic overview of the three iterative cycles, as well as the data collection and analysis events.

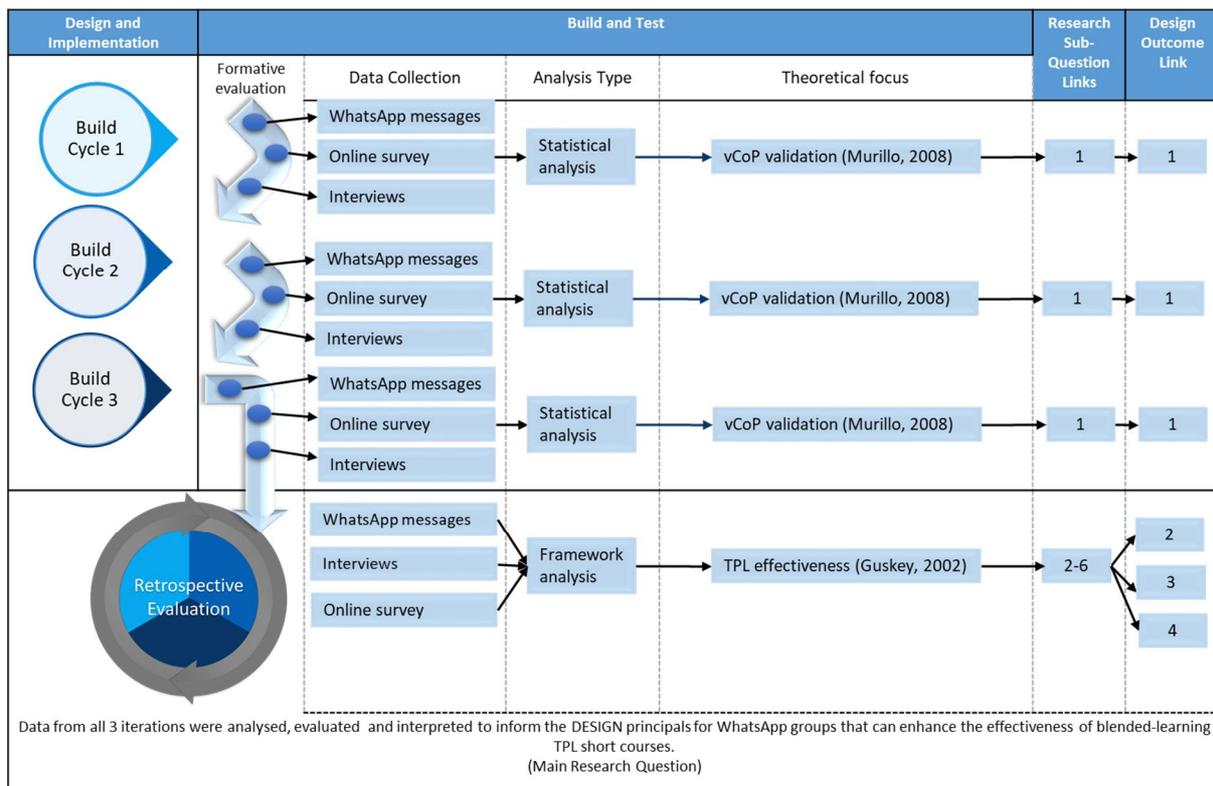


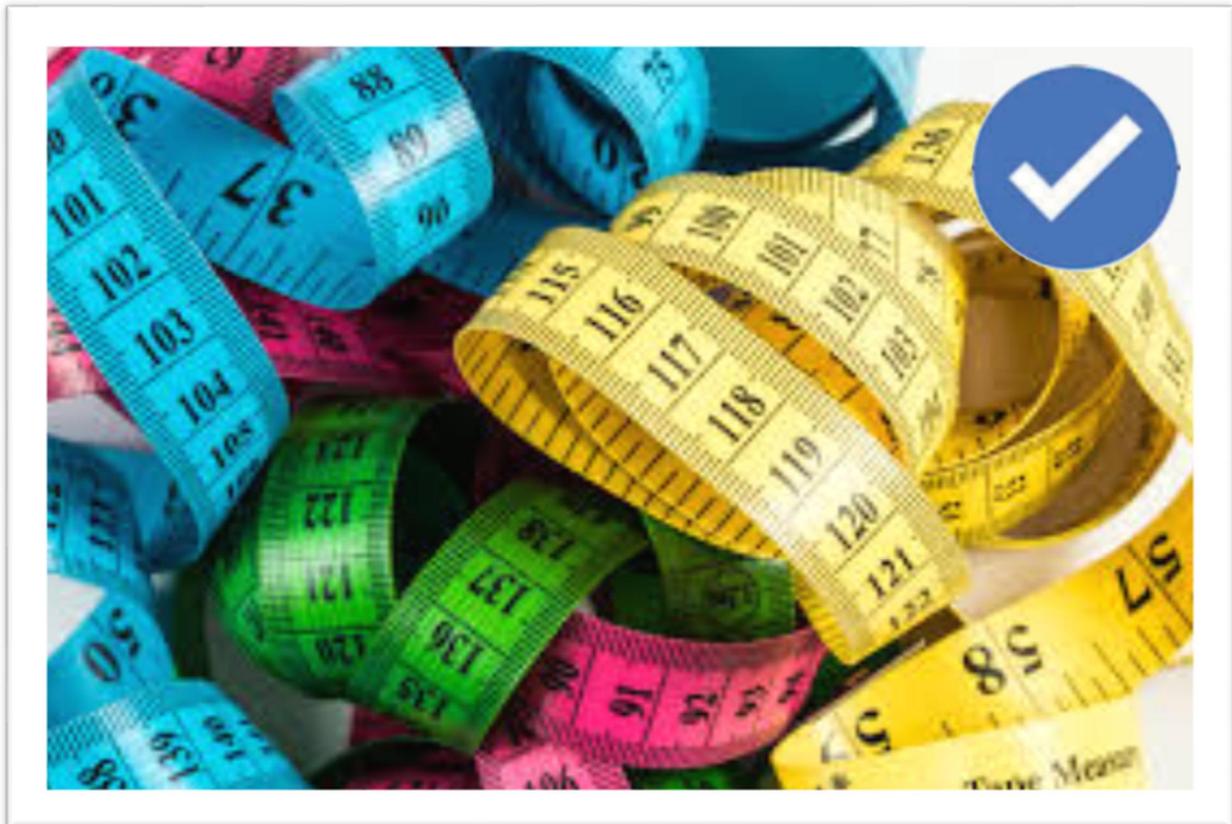
Figure 4.24: Diagrammatic overview showing the links between the three iterative cycles, the data collection and analysis events, the theoretical frameworks, the research questions and the design outcomes.

4.8 Summary

In this chapter the methodology, research design and research process of this study were discussed. To demarcate this study's methodology, arguments for and against DBR, similarities with other methodologies and the use of DBR in higher degree research were

interrogated. This was followed by a description of the general research design and process of a DBR study, which flowed into this study's DBR build step expansion. This included an overview of the iterative cycles and the design process. Within the design process, the hypothetical support trajectory was discussed, expanding into a discussion of the four design outcomes. This was followed by a discussion of the data collection instruments that were used, as well as the reliability, validity and trustworthiness of the instruments. Finally the data analysis approaches were explained.

In the next chapter the formative and retrospective analyses of the mainly quantitative data collected through the VCoP validation questionnaire, are presented.



TEST: Part 1

- Formative evaluation of the build cycles as VCoPs
- Two summative, retrospective evaluations of the build cycles to inform sub-research question 1

CHAPTER 5: ITERATIVE BUILD CYCLES: PRESENTATION, ANALYSIS & INTERPRETATION OF RESULTS OF VCoP EFFECTIVENESS

"Effective feedback occurs during the learning, while there is still time to act on it."
(Chappuis, 2012, p. 38)

5.1 Introduction

In this chapter the study's test step, the presentation and analysis of mainly quantitative data, is conducted. This is followed by two retrospective analyses and evaluations of the data in answer to sub-research question 1: Which essential traits of a VCoP were fostered in each WhatsApp group's DBR cycle? This chapter represents step 6 in the Easterday et al. (2017) proposed seven-step iterative process for DBR - *test the solution*. Figure 5.1 provides a detailed outline of this chapter.

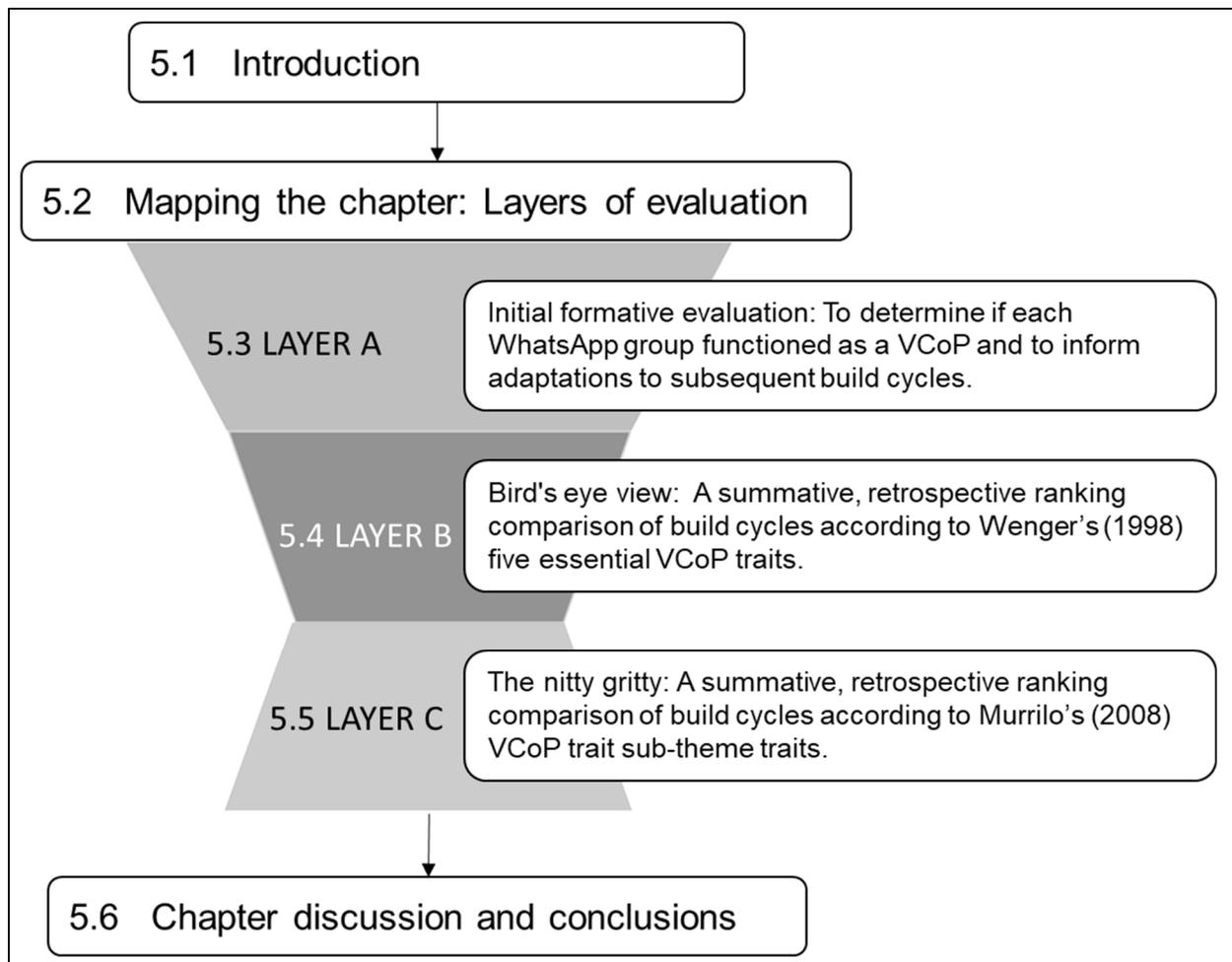


Figure 5.1: Chapter 5 outline.

5.2 Mapping the chapter - layers of evaluation

In DBR the research questions are informed by two types of evaluation: (i) the formative evaluation between iterative cycles, as well as (ii) the retrospective, summative analysis, which is done after all building cycles³¹ have been completed. The analysis of the data from Murillo's (2008) VCoP validation survey instrument is displayed and interpreted in different layers of complexity, focussing on Wenger's (1998) five essential traits of a VCoP and Murillo's sub-themes for each trait.

Cycle 1 consisted of a minimally structured WhatsApp group and supported teachers in a Natural Sciences TPL short course in the Western Cape Province of South Africa in 2015. The researcher created the WhatsApp group two weeks before the start of the course and it was used as support for the short course for a total of 5 months. Cycle 2 had a facilitated structured WhatsApp group and supported teachers in a Life Sciences TPL short course in the Northern Cape Province of South Africa in the first half of 2017. The researcher created the WhatsApp group at the end of the contact session and it was used as support for the short course for a total of 4 months. Cycle 3 was a highly structured WhatsApp group and supported teachers in a Natural Sciences TPL short course in the Western Cape in the second half of 2017. The researcher created the WhatsApp group a week before the start of the course and it was used as support for the short course for a total of 4 months.

A) **Initial evaluation:** Presented in this layer is the analysis and interpretation of data received after the conclusion of each cycle from Murillo's validated (2008) VCoP validation questionnaire. The researcher formatively evaluated each of Cycles 1 and 2 to inform the subsequent cycle. Cycle 3 was also formatively evaluated, but as it was the last cycle in the study, it did not inform a subsequent cycle. The aims of the initial evaluation are threefold. Firstly, to formatively assess whether and how each WhatsApp group functioned as a VCoP. Secondly, to inform each subsequent cycle on possible improvements, and thirdly to answer sub-research question 1: Which essential traits of a virtual community of practice (VCoP) were fostered in each WhatsApp VCoP? (Figure 5.2).

³¹ To assist readability, the term cycle will be used to denote build or building cycle from this chapter onwards.

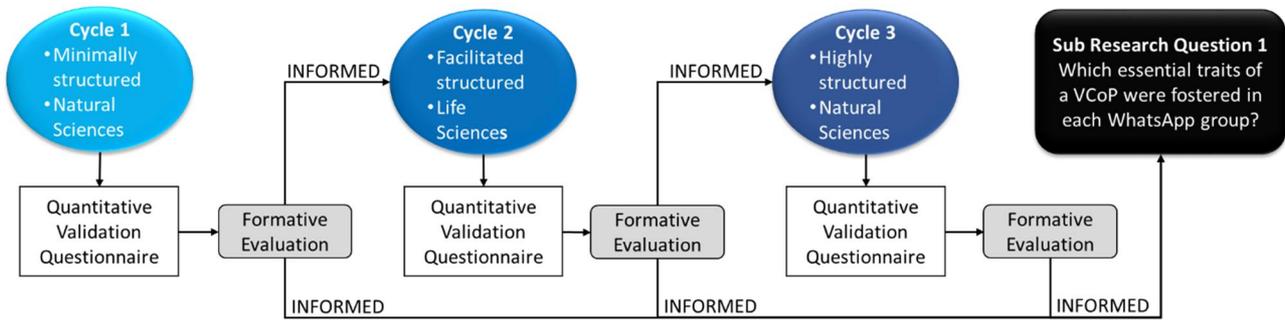


Figure 5.2: Representation of the initial evaluation process.

B) **Bird's-eye view:** This layer comprises of a concise, summarised, retrospective comparison between the results of the three cycles, grouped by essential traits. The two main aims of the retrospective evaluation are to rank the three build cycles regarding their initial effectiveness in fostering Wenger's (1998) essential traits of CoPs, and to subsequently inform sub-research question 1 (Figure 5.3).

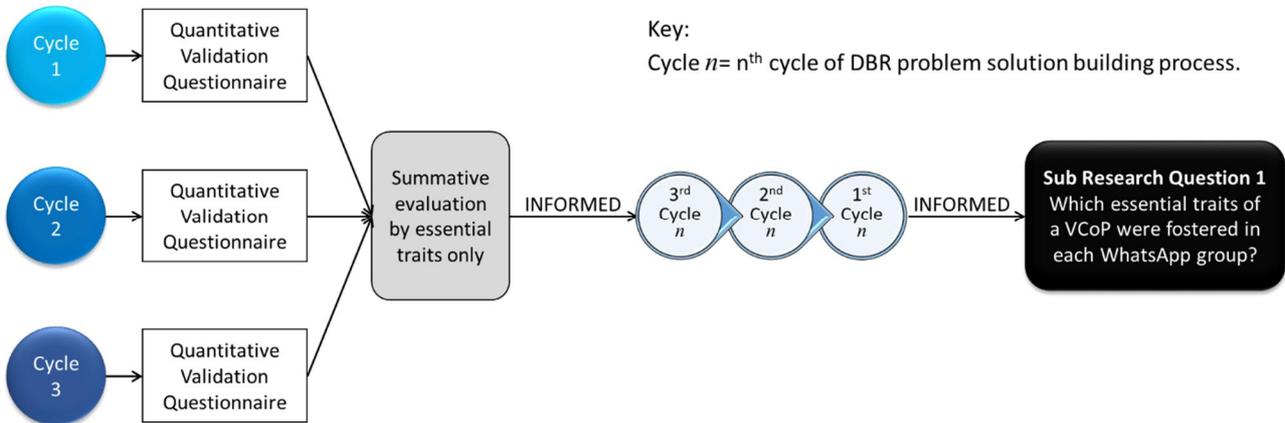


Figure 5.3: Representation of the first retrospective evaluation process.

C) **The nitty gritty:** In this layer the researcher presents a further summative and retrospective analysis of the data. This second retrospective evaluation focusses on Murillo's (2008) sub-themes, sequenced according to Wenger's (1998) essential traits of CoPs, in answer to sub-research question 1 (Figure 5.4).

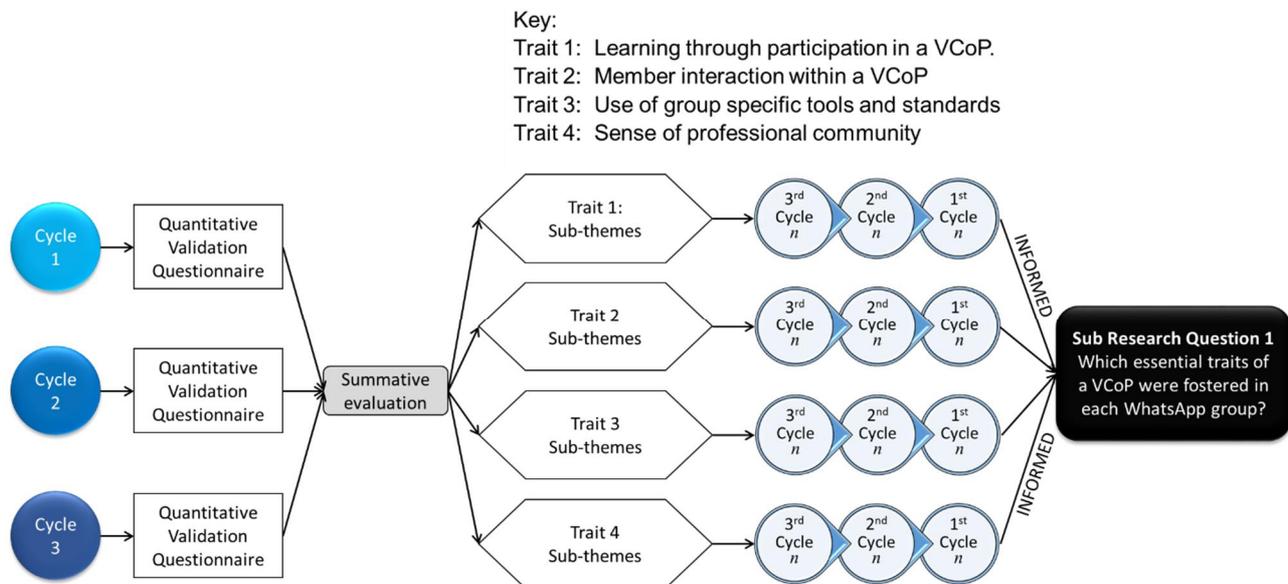


Figure 5.4: Representation of the second retrospective evaluation process.

5.3 Initial formative evaluation (Layer A)

In this section the researcher presents the quantitative data analysis for each cycle, followed by the qualitative data analysis. Formative evaluation of Cycles 1 and 2 informed changes to subsequent cycles. Cycle 3 was also formatively evaluated, but as it was the last cycle in the study, it did not inform a subsequent cycle.

The main focus of the formative evaluation was to determine what adaptations had to be made to subsequent cycles. Non-negative grouping is a method often utilised in medical or psychological attitudinal research, such as that of Tsumura, Sensaki and Shimada (2015) and Almeida et al. (2014). Non-negative grouping allows the researcher to easily identify areas requiring adaptation for subsequent cycles (Almeida et al., 2014).

The second focus of this evaluation was to determine whether each WhatsApp group functioned as a valid VCoP with regard to the four Wenger (1998) essential traits that were quantitatively analysed. The sum of the non-negative responses (strongly agree, agree, neutral), obtained from the associated Likert scale items, were therefore calculated. A sum of 50% or more indicated that a valid VCoP had formed. To assist with the interpretation, the results from the survey instrument are presented in graphical format.

5.3.1 Formative evaluation of Cycle 1 in answer to research question 1

Cycle 1, the minimally structured VCoP that aligned with the heutagogical approach of self-determination, was successful as a VCoP with regard to the four Wenger's (1998) essential

traits of CoPs that were quantitatively analysed. The sum of the non-negative responses of each of the four essential traits were well above 50%. For *learning through participation in a VCoP* (Trait 1), a total of 91% was obtained for the combined non-negative perceptions,³² compared to a 9% combined disagreement response. *Member interaction within the VCoP* (Trait 2) showed a combined non-negative perception of 88%, compared to a combined disagreement response of 12%. For the *use of group specific tools and standards in the VCoP* (Trait 3), the combined non-negative perception was 96%, compared to a combined disagreement response of 4%. The *presence of a sense of community in the VCoP* (Trait 4) showed a combined non-negative perception of 85%, compared to a combined disagreement response of 15%. A more in-depth analysis of these results, ordered by essential traits, follows in the next sections.

5.3.1.1 Cycle 1 respondents' perception of learning through participation in the VCoP (Trait 1)

The results in Figure 5.5 show that the majority (52%) of Cycle 1 respondents agreed that they had learned through participation in the group. There was also a combined non-negative perception of 91%. Only 9% of the respondents indicated that the WhatsApp group did not contribute to their learning (combined disagreement responses). Cycle 1 was therefore effective in *supporting learning through participation in the VCoP* (Trait 1). The analysis of this trait's sub-themes, to determine if any action was needed to improve Cycle 2 participants' perception of *learning through participation in the VCoP*, is presented in section 5.3.1.5.

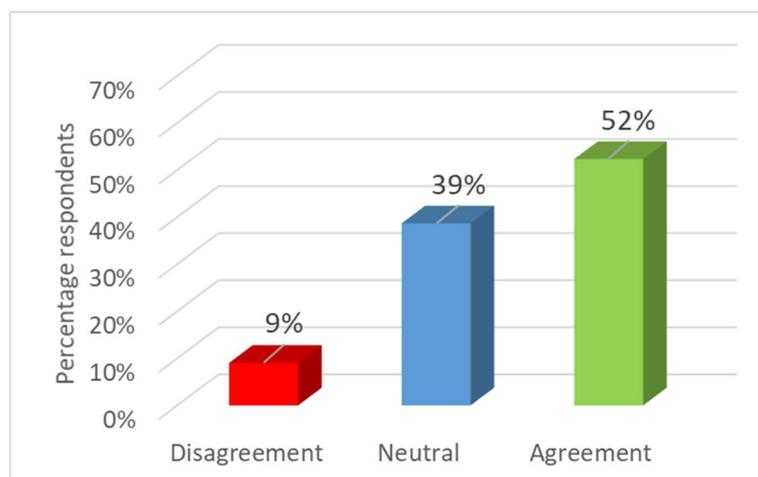


Figure 5.5: Cycle 1 respondents' perception of *learning through participation in the VCoP*.

³² The combined non-negative responses are the sum of the strongly agree, agree and neutral responses.

5.3.1.2 Cycle 1 respondents' perception of member interaction in the VCoP (Trait 2)

Cycle 1 respondents were of the perception that there was satisfactory member interaction in the WhatsApp group (Figure 5.6)³³, as the combined non-negative perception was 88%. Twelve percent of the participants indicated that they did not experience satisfactory member interaction in the WhatsApp group (disagreement responses). This, together with a combined agreement level of 48% meant though that some action needed to be taken in subsequent cycles to improve VCoP members' interaction with one another. To inform the changes for Cycle 2, this trait's sub-themes were analysed. This analysis is presented in section 5.3.1.6.

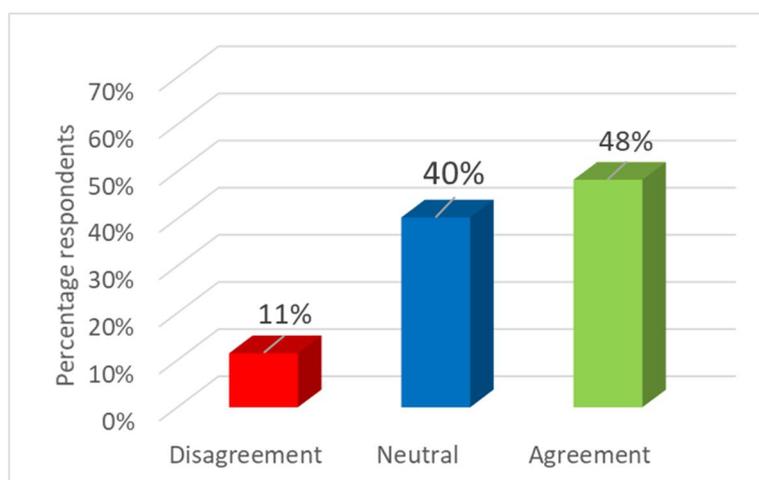


Figure 5.6: Cycle 1 respondents' perception of *member interaction in the VCoP*.

5.3.1.3 Cycle 1 respondents' perception of the use of WhatsApp group specific tools and standards in the VCoP (Trait 3)

The results in Figure 5.7 indicate a 96% combined non-negative response to the perception that respondents utilised WhatsApp group specific tools and standards in the VCoP. Only 4% of the participants did not experience satisfactory use (disagreement responses). However, the combined agreement responses of only 44% showed the need for action to be taken in subsequent cycles to improve participants' perception of the *use of WhatsApp group specific tools and standards in the VCoP*. To inform the changes in Cycle 2, this trait's sub-themes were analysed. The analysis is presented in section 5.3.1.7.

³³ All percentages were rounded to zero decimal places creating certain scenarios where it may appear as if the sum of data sample percentages may be less, or more than 100%. When the percentages are however viewed to more decimal places the discrepancy disappears.

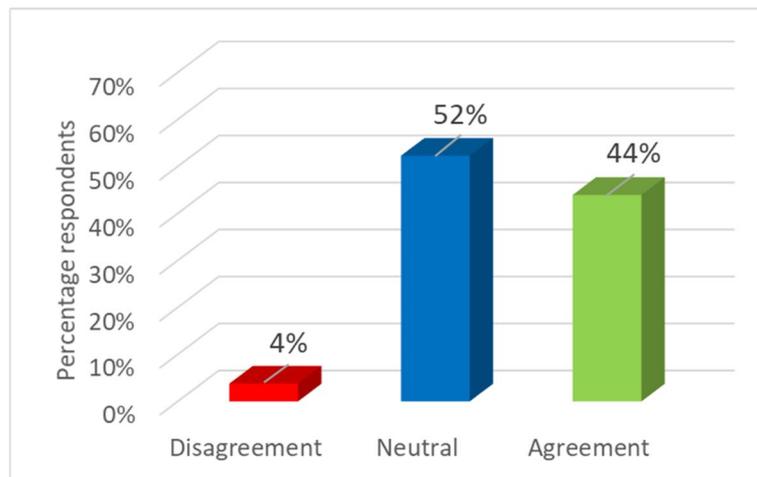


Figure 5.7: Cycle 1 respondents' perception of the *use of WhatsApp group specific tools and standards in the VCoP*.

5.3.1.4 Cycle 1 respondents' perception of a sense of community in the VCoP (Trait 4)

The majority (51%) of Cycle 1 respondents perceived a satisfactory presence of a sense of community within the WhatsApp group (Figure 5.8). There was also a combined non-negative response of 85%. Only 15% of the participants indicated that they did not perceive satisfactory presence of a sense of community (combined disagreement responses).

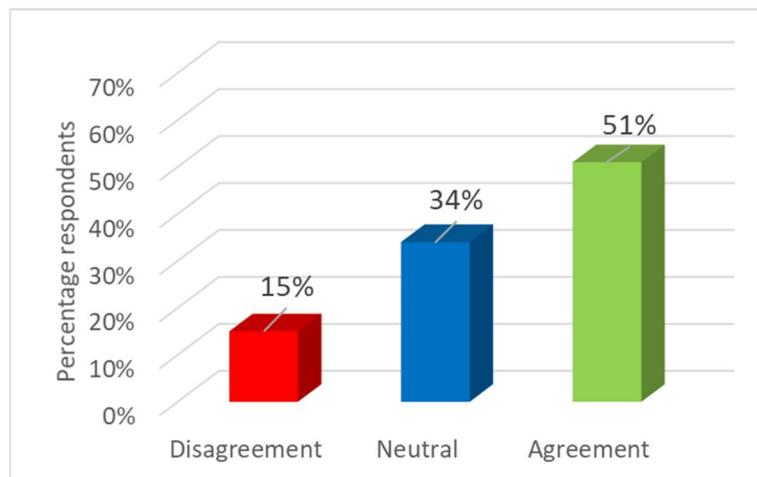


Figure 5.8: Cycle 1 respondents' perception of the presence of a *sense of community in the VCoP*.

5.3.1.5 Cycle 1 respondents' perception of sub-themes within learning through participation in the VCoP (Trait 1)

The results in Figure 5.9 show that there were agreement on all three sub-themes in the *learning through participation in the VCoP* trait. The combined non-negative perceptions of sub-themes within *learning through the participation in the VCoP* were: (i) *improving professional skills* - 92% (sub-theme 1A), (ii) *acquisition of new knowledge* - 92% (sub-theme 1B) and (iii) *identifying with the profession* - 89% (sub-theme 1C). The results imply

that overall, Cycle 1 succeeded in supporting these three sub-themes and there was therefore no need for actions to improve these sub-themes in Cycle 2.

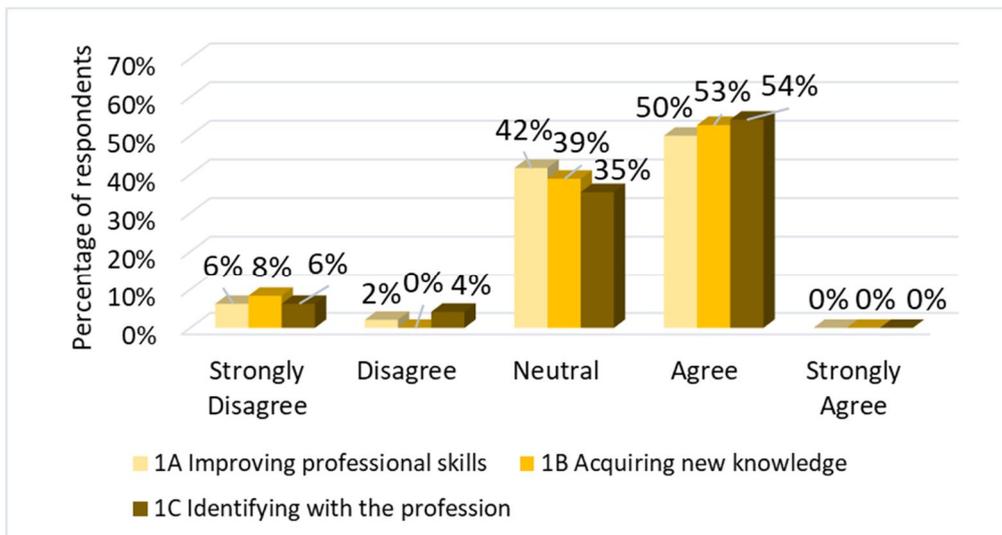


Figure 5.9: Cycle 1 respondents' perception of sub-themes within *learning through participation in the VCoP* (Trait 1).

5.3.1.6 Cycle 1 respondents' perception of sub-themes in member interaction in the VCoP (Trait 2)

The results in Figure 5.10 show a combined non-negative perception for the sub-theme *collective problem solving in the VCoP* of 94%. This implies that Cycle 1 succeeded in supporting collective problem solving. The combined non-negative perception that *domain-related issues were debated in the VCoP* (83%) means that the participants were in agreement that the VCoP supported this sub-theme. Domain-related issues refer to both topic and conceptually relevant issues within the TPL short course. Topic relevant issues refer to general teaching issues, as well as either Natural Sciences (Cycle 1 and 3) or Life Sciences (Cycle 2) teaching discussions. Discussion of conceptually relevant issues refer to discussions about concepts and misconceptions within the two topics. The combined disagreement response for this sub-theme was 17%. This was a clear formative indicator that more focus had to be placed in Cycle 2 on ensuring that domain-related issues were presented to the participants, and that topical issues that would encourage debate, had to be included.

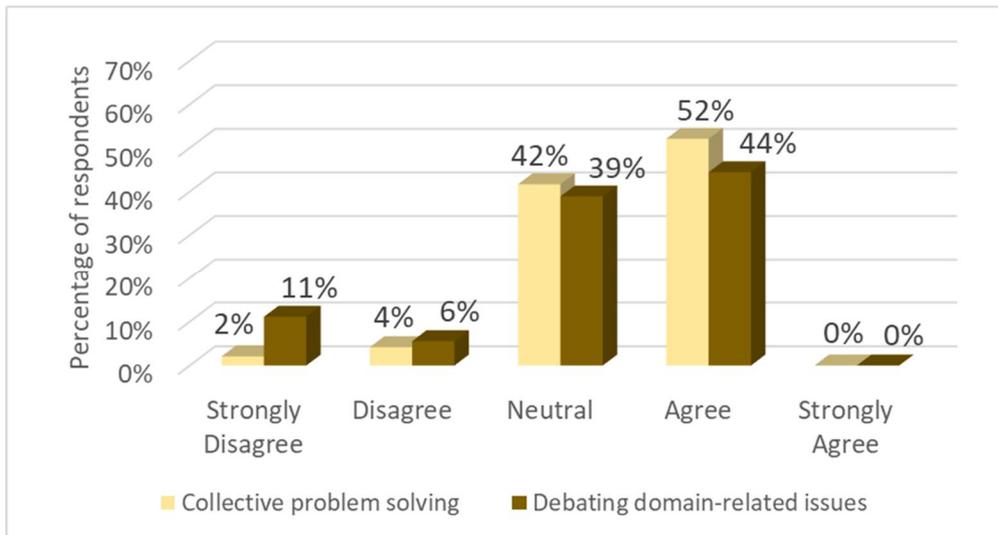


Figure 5.10: Cycle 1 respondents' perception of sub-themes within *member interaction in the VCoP* (Trait 2).

5.3.1.7 Cycle 1 respondents' perception of sub-themes within the use of WhatsApp group specific tools and standards in the VCoP (Trait 3).

Respondents in Cycle 1 were of the opinion that participants had *shared their practices in the VCoP*, as there was a combined non-negative response of 97% for this sub-theme (Figure 5.11). Respondents were also of the opinion that there was a perception of *shared criteria in the VCoP*, as there was a combined non-negative response of 95% for this sub-theme. Despite the fact that the combined agreement responses for both sub-themes were below 50%, the researcher could find no clear indication that any specific sub-theme negatively influenced the results. Cycle 1 therefore succeeded in supporting these two sub-themes and there was no need for actions to improve these sub-themes in subsequent cycles.

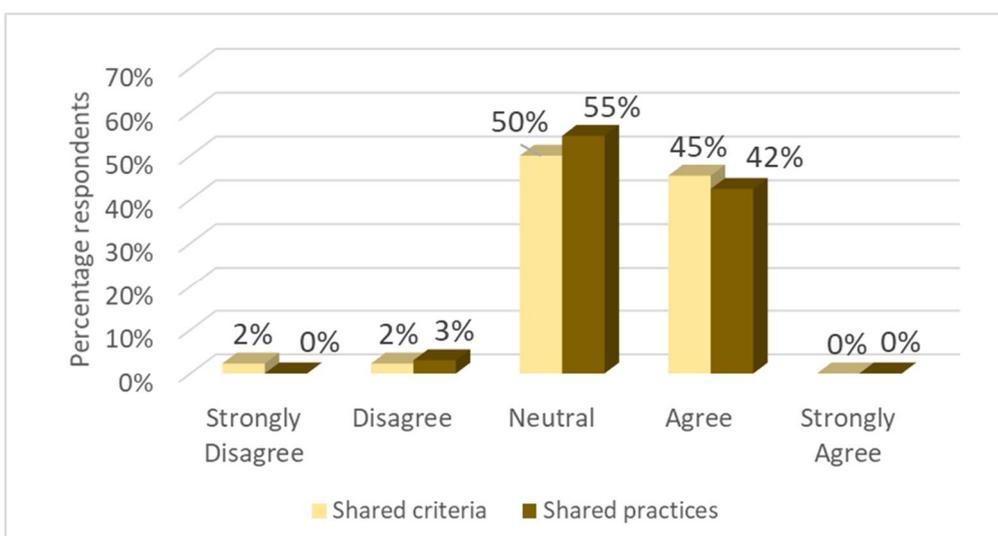


Figure 5.11: Cycle 1 respondents' perception of sub-themes within the *use of WhatsApp group specific tools and standards in the VCoP* (Trait 3).

5.3.1.8 Cycle 1 respondents' perception of sub-themes within the presence of a sense of community in the VCoP (Trait 4)

The results in Figure 5.12 show that there was a very strong 66% agreement on the sub-theme about the existence of a *shared sense of professional community in the VCoP*. There was also a combined non-negative perception of 92%. Regarding the sub-theme about *members' knowledge of each other in the VCoP*, there was 36% agreement and a 42% neutral response rate, suggesting a combined non-negative perception of 78%. As well as registering lower agreement rates, the latter theme also registered a combined disagreement level of 22%. These results implied that some action had to be taken in subsequent cycles to ensure that members engaged in a manner that encouraged them to get to know each other professionally. Overall there were, however, more positive than negative perceptions of the existence of both these sub-themes in Cycle 1.

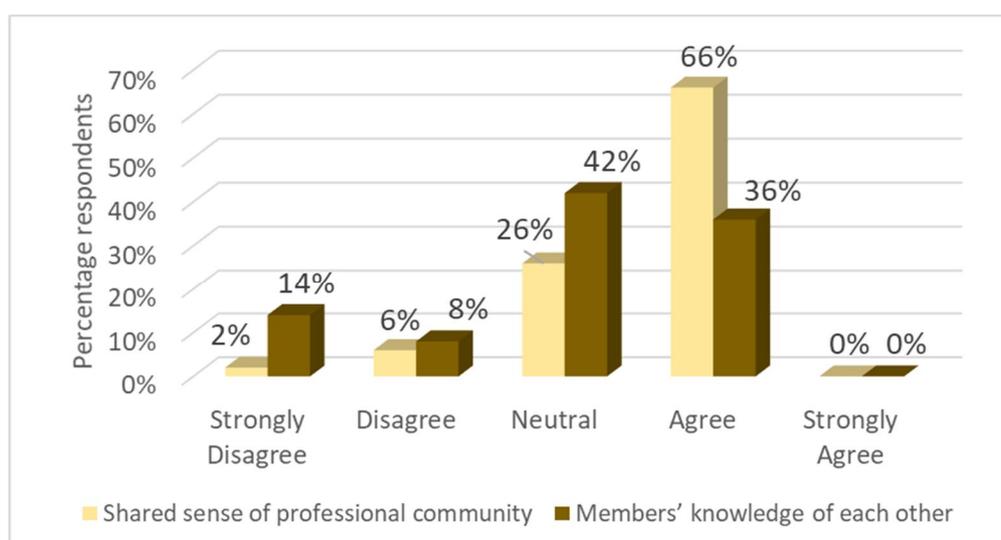


Figure 5.12: Cycle 1 respondents' perception of sub-themes within the presence of a *sense of community in the VCoP (Trait 4)*.

5.3.1.9 Cycle 1 respondents' perception of caring for a domain of knowledge or joint enterprise in the VCoP (Trait 5).

Nine out of the 12 respondents in the VCoP validation questionnaire completed the qualitative, open-ended question. All nine started their answers with a positive response such as "yes" (7), "definitely" (1) or "absolutely" (1). The explanation of their answers were then thematically analysed for themes relating to joint enterprise on the WhatsApp group. Murillo (2008) pinpointed two themes that refer to joint enterprise in a VCoP: (i) *The VCoP can achieve a professional orientation* and (ii) *the VCoP can maintain focussed discussion*. These two themes served as *a priori* themes. Each theme linked to one *a priori* code. Qualitative, thematic analysis is usually an inductive process where themes and codes

emerge from the analysis of the data. In cases where the research is led by specific themes, as is the case in this section, thematic analysis can be deductive (Crabtree & Miller, 1999; Fereday & Muir-Cochrane, 2006).

Miles, Huberman and Saldana (2013) define codes as tags for allocating units of meaning to narrative or descriptive data collected during a study. The theme, the *VCoP can achieve a professional orientation*, linked to the code #professional_orientation. The theme, the *VCoP can maintain focussed discussion*, linked to the code #focussed_discussion.

Professional orientation refers to participants mentioning in their responses that discussions of teaching practices or TPL related topics took place in the VCoP, e.g.

C1_Teacher 01³⁴: Tydens die kursus het ander onderwysers se praktyke gehelp om my eie praktyke aan te pas. [Translation: During the course other teachers' practices assisted me to adapt my own practices]

C1_Teacher 03: ...ek het baie by die "ouer onderwysers" geleer. Hulle het goeie raad en advies gegee. [Translation: I learned a lot from the "older teachers". They gave good guidance and advice.]

C1_Teacher 07: ...because we had enough time to discuss and make meaning amongst ourselves. We learned from each other all the time.

Focussed discussions refer to participants mentioning in their answer that TPL subject related content (Natural Sciences teaching in Cycle 1) was discussed in the VCoP, e.g.

C1_Teacher 04: Ek kon maklik met enige van die fasiliteerders of ander kollegas in verbinding tree... of dalk as ek apparaat nodig gehad het vir eksperimente. [Translation: I could easily reach any of the facilitators or other colleagues...or perhaps if I needed apparatus for experiments]

C1_Teacher 05: I could easily turn to the group if I needed any help with anything regarding science.

C1_Teacher 09: ...ek kon enige probleem wat ek in die klas ondervind (bv. 'n eksperiment wat nie wou werk nie) met die groep bespreek en het altyd antwoorde vir my vrae gekry. [Translation: I could discuss any problem that I encountered in class with the group (e.g. an experiment that did not work) and always received answers to my questions]"

The presence of these themes in the respondents' answers means that the respondents experienced the VCoP as a joint enterprise space. Consequently, Cycle 1 succeeded in

³⁴ Participant names were anonymised. In Cycle 1 all participant pseudonyms start with C1.

supporting *caring for a domain of knowledge in the VCoP*. There was therefore no need to adapt Cycle 2 for this trait.

5.3.1.10 Summary of respondents' perceptions of the existence of essential traits in the VCoP in Cycle 1.

From the analysis of the VCoP validation questionnaire for Cycle 1, the minimally structured VCoP that aligned with the heutagogical approach of self-determination, it was determined that the Cycle 1 WhatsApp group generally succeeded in supporting all of Wenger's (1998) five essential traits for CoPs. When focussing on the sub-themes though, actions had to be taken in subsequent cycles to enhance perception of the existence of the sub-themes *debating domain-related issues* and *members' knowledge of each other in the VCoP*. A discussion of the adaptations to Cycle 2 follows in the next section.

5.3.1.11 Adaptations to design of Cycle 2 regarding domain-related issues in the VCoP and members' knowledge of each other in the VCoP

In response to the formative evaluation of data collected from the VCoP validation instrument in Cycle 1, (i) more focus had to be placed on ensuring that domain-related issues were presented to the participants and (ii) topical issues needed to be chosen that would encourage debate, so that participants could get to know each other professionally. As these sub-themes also link to design outcome 2, the creation of an environment that decreases transactional distance (TD), the researcher had to incorporate elements from transactional distance theory in the WhatsApp group discussions. Increasing instructor-learner interactions could increase dialogue and lead to the lowering of TD (Falloon, 2011; Moore, 1993; 2013). Instructor-learner interactions also speak to teaching presence. To increase teaching presence, while lowering TD, participants in Cycle 2 were therefore regularly prompted to share, on the WhatsApp group, questions or problems that they encountered when teaching the TPL short course material. In Figure 5.13 an example of such a question can be seen.

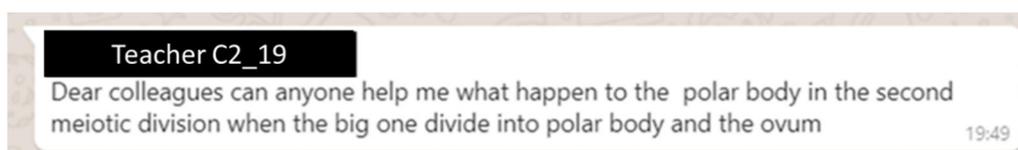


Figure 5.13: WhatsApp message screenshot³⁵ of a participant's question in Cycle 2.

³⁵ Screenshot with the light-brown background was taken from the desktop version of WhatsApp.

To answer this type of question, the researcher would first allow sufficient time to pass, thereby allowing other participants the opportunity to respond and possibly start a domain-related discussion. Allowing participants time to respond is an example of the WhatsApp platform's affordance of asynchronous communication. An example of a domain-related discussion that followed the question posted by Teacher C2_19 can be seen in Figure 5.14.

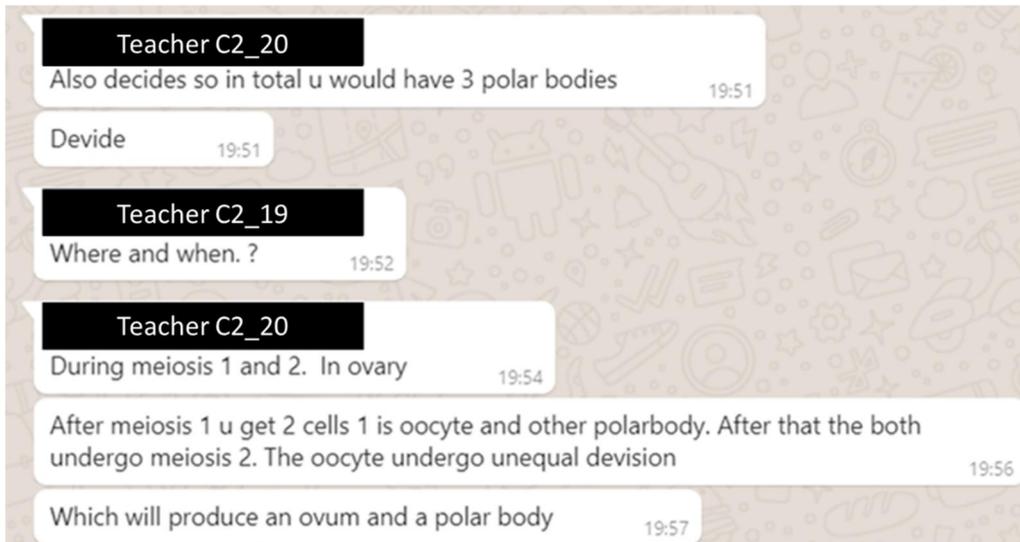


Figure 5.14: WhatsApp message screenshot of participant discussion responses in Cycle 2.

If the researcher perceived that more explanation was needed in any particular WhatsApp group discussion, or a misconception was perpetuated, she added her voice to the discussion in the form of narratives, images, videos, or links to internet sites. This strategy spoke to minimising transactional distance (design outcome 2) and sharing of practice-based content that supports and enhances TPL students' course needs (design outcome 3). Figure 5.15 shows a screenshot of a post by the researcher as follow-up post to the discussion started by Teacher C2_19 in Figure 5.13.

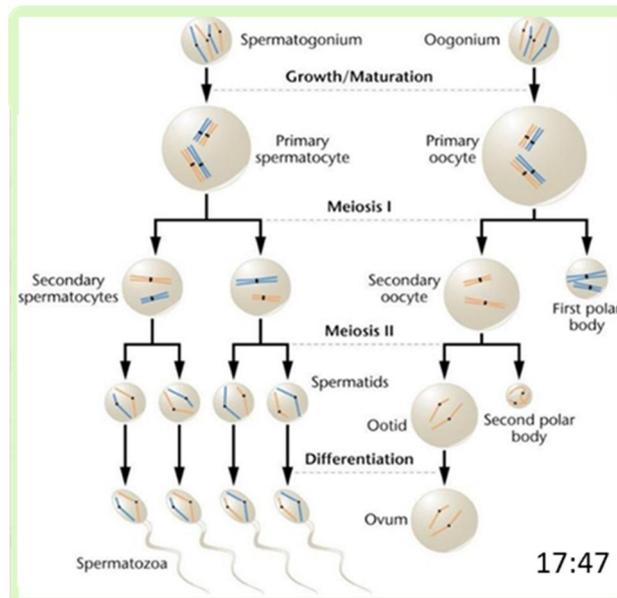


Figure 5.15: WhatsApp message screenshot³⁶ of image posted by the researcher in Cycle 2.

The discussion would then be allowed to continue and, if needed, e.g. if a misconception surfaced, the researcher would join the discussion again. The strategy of discussing topic specific questions and misconceptions meant that teachers' TSPCK were also supported on the WhatsApp groups. In the example at hand, the researcher could assist in clearing the misconception by adding a link to an explanatory video clip (Figure 5.16).

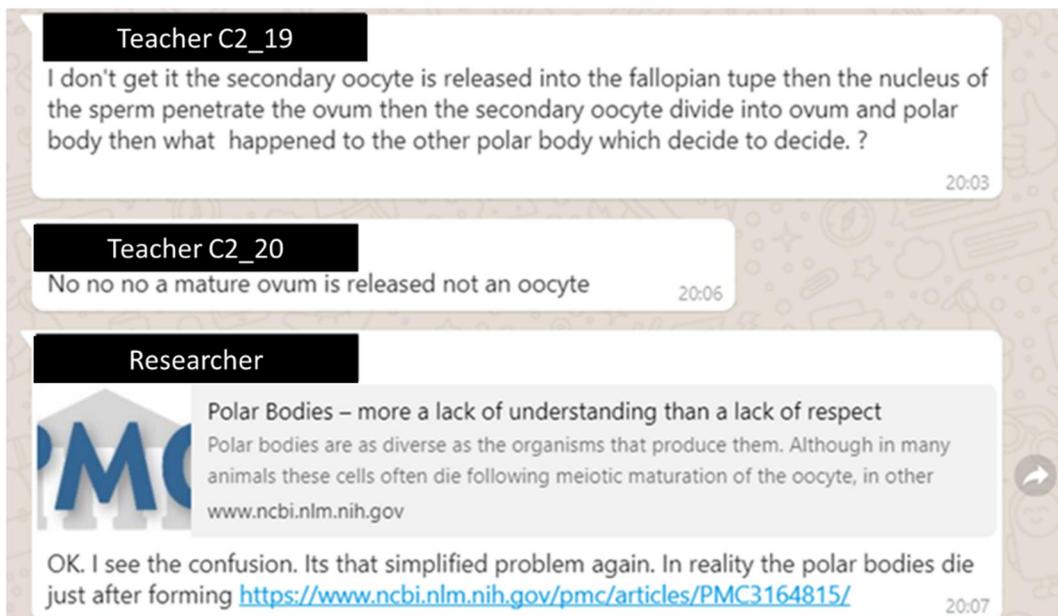


Figure 5.16: WhatsApp message screenshot of a discussion with a link to a video clip, posted by the researcher, in Cycle 2.

³⁶ Screenshots with a green background was taken from a mobile phone version of WhatsApp

Another strategy applied by the researcher to encourage debate and prompt participants to get to know each other professionally (sub-theme 4B), was to post discussion vignettes, linked to the participants' questions or to material from the TPL short course. This strategy links to sharing of practice-based content support (design outcome 3). Hughes and Huby (2004) describe vignettes as stimuli which are used to entice responses from research participants. These stimuli can be text, images or even video material. A vignette is defined by the Collins dictionary³⁷ as "a short description, picture, or piece of acting which expresses very clearly and neatly the typical characteristics of the thing that it represents." In this study vignettes are presented as short descriptions of, or pictures depicting, scientific concepts or processes. The use of vignettes follows from Finch's (1987) proposal to use vignettes to encourage debate and Bernabeo et al.'s (2013) findings that the use of vignettes could encourage a sense of professional community. Vignettes were chosen to address scientific topics that participants had struggled with during the contact session, or were developed from sample examination questions that, according to the *National Senior Certificate 2018 Diagnostic Report* (Department of Basic Education, 2018), were answered unsatisfactorily by learners. These vignettes also fall under support of TSPCK. Figure 5.17 shows an example of a vignette posted in Cycle 2.



Figure 5.17: WhatsApp message screenshot of a vignette posted by the researcher in Cycle 2.

³⁷ <https://www.collinsdictionary.com/dictionary/english>

The researcher would then wait for replies from the participants, prompting them to enter into discussions. In Figure 5.18 an example of some of the replies to the vignette in Figure 5.17 can be seen.

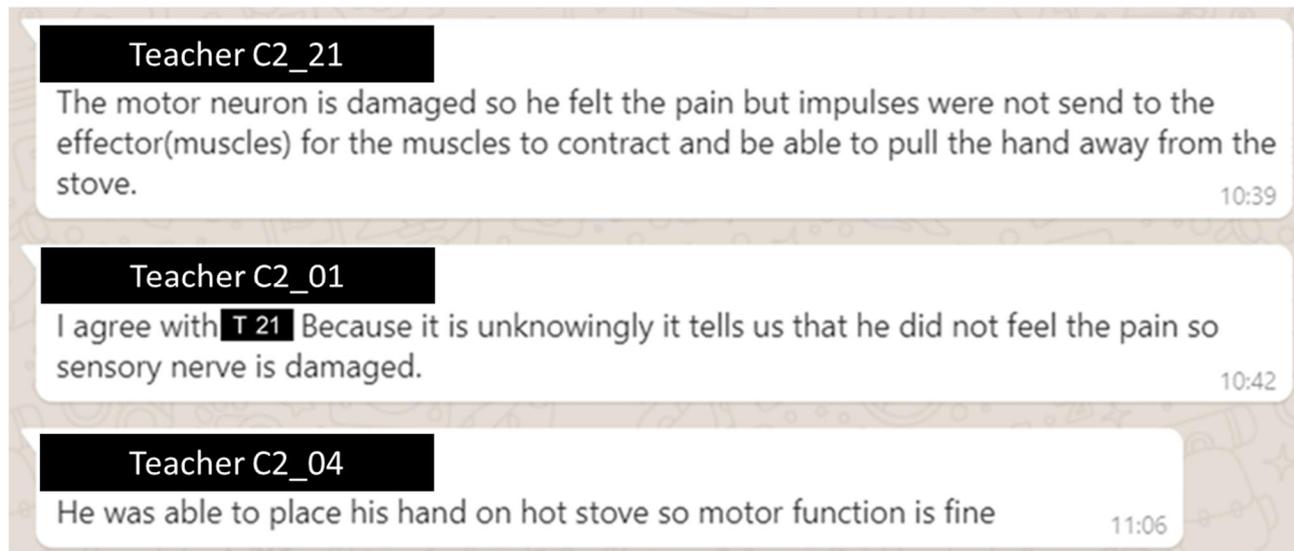


Figure 5.18: WhatsApp message screenshot of posts following the posting of a vignette by the researcher in Cycle 2.

Participants in Cycle 2 were also discouraged from posting any off-topic (e.g. overtly social) messages. The researcher determined the extent of the success of these adaptations through the formative evaluation of Cycle 2.

5.3.2 Formative evaluation of Cycle 2 in answer to research question 1

Cycle 2 was a facilitated structured VCoP that aligned with the andragogical approach of self-directedness. Overall, it was effective as VCoP with regard to the four Wenger (1998) essential traits of a CoP that were quantitatively analysed, as the combined non-negative responses of each of the four associated Likert scale items were well above 50%. For *learning through participation in a VCoP* (Trait 1) the combined non-negative perception was 72%, compared to a 28% combined disagreement response. *Member interaction within the VCoP* (Trait 2) showed a combined non-negative perception of 89% with a 12% combined disagreement response³⁸. For the *use of group specific tools and standards in the VCoP* (Trait 3) the combined non-negative perception was 90%, compared to a 10% combined

³⁸ All percentages were rounded to zero decimal places creating certain scenarios where it may appear as if the sum of data sample percentages may be less, or more than 100%. When the data is however viewed to more decimal places this discrepancy disappears.

disagreement response. The presence of a *sense of community in the VCoP* (Trait 4) showed a combined agreement response of 80%, with a 20% combined disagreement response. A more in-depth analysis of these results, ordered by essential traits, follows in the next sections.

5.3.2.1 Cycle 2 respondents' perception of learning through participation in the VCoP (Trait 1)

The results in Figure 5.19 show that Cycle 2 respondents were generally of the perception that they had *learned through participation in the VCoP*, as the combined non-negative response was 72%. However, as this cycle registered a combined disagreement level of 28%, some action had to be taken in subsequent cycles to improve learning through participation in the VCoP. This led to the analyses of the sub-themes of this trait (section 5.3.2.5) to inform changes to Cycle 3.

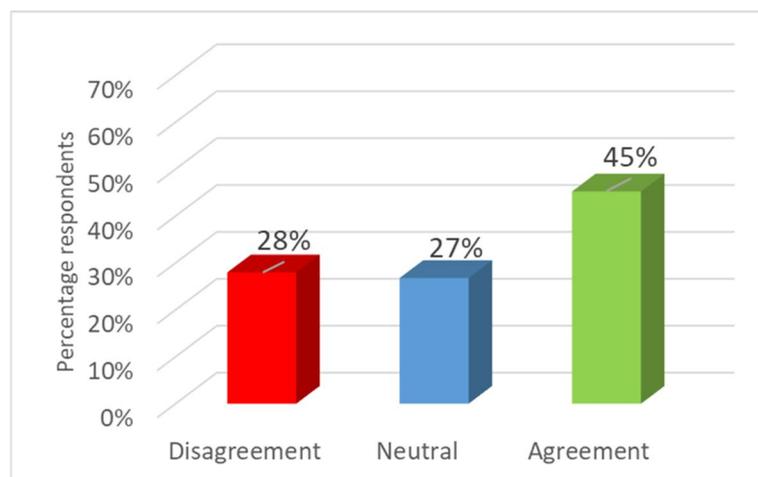


Figure 5.19: Cycle 2 respondents' perception of *learning through participation in the VCoP*.

5.3.2.2 Cycle 2 respondents' perception of member interaction in the VCoP (Trait 2)

From the results in Figure 5.20, Cycle 2 respondents were of the perception that there was satisfactory *member interaction in the VCoP*, as the combined non-negative response was 89%. The low agreement response (45%) meant, however, that adaptation to the VCoP model was needed to increase member perception of interaction in Cycle 3. This led to the further investigation of this trait by analysing the trait's sub-themes (section 5.3.2.6) to inform the adaptations to Cycle 3.

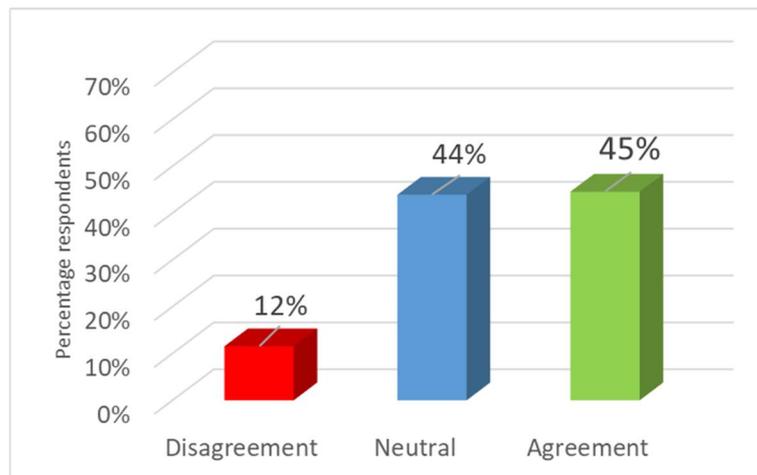


Figure 5.20: Cycle 2 respondents' perception of *member interaction in the VCoP*.

5.3.2.3 Cycle 2 respondents' perception of the use of WhatsApp group specific tools and standards in the VCoP (Trait 3)

The results in Figure 5.21 show that there was a 54% agreement on the perception that WhatsApp group specific tools and standards were used in the VCoP in Cycle 2. There was also a strong combined non-negative perception of 90%. Only 10% of the participants indicated that they did not experience satisfactory use of WhatsApp group specific tools and standards (combined disagreement responses). Cycle 2 therefore succeeded in supporting the *use of WhatsApp group specific tools and standards in the VCoP*. To determine if any action was needed to improve Cycle 3, participants' perception of this theme's sub-themes was analysed. The analysis is presented in section 5.3.2.7.

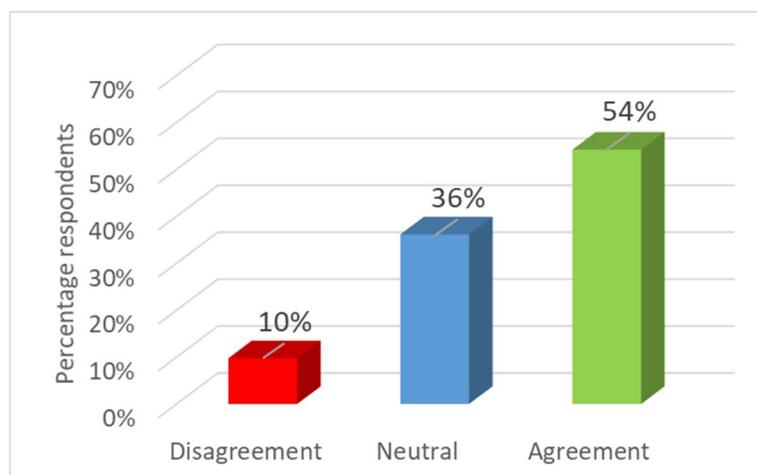


Figure 5.21: Cycle 2 respondents' perception of the *use of WhatsApp group specific tools and standards in the VCoP*.

5.3.2.4 Cycle 2 respondents' perception of a sense of community in the VCoP (Trait 4)

In Cycle 2, according to the results in Figure 5.22, the majority of the respondents (54%) agreed that they perceived a satisfactory presence of *a sense of community within the VCoP*. There was also a strong combined non-negative perception of 80%. However, 20% of the participants indicated that they did not perceive satisfactory presence of a sense of community within the WhatsApp group (combined disagreement responses). This meant that some action needed to be taken in Cycle 3 to improve the existence of the presence of *a sense of community within the VCoP*. To determine if any action was needed to improve Cycle 3, participants' perception of this theme's sub-themes was analysed. The analysis is presented in section 5.3.2.8.

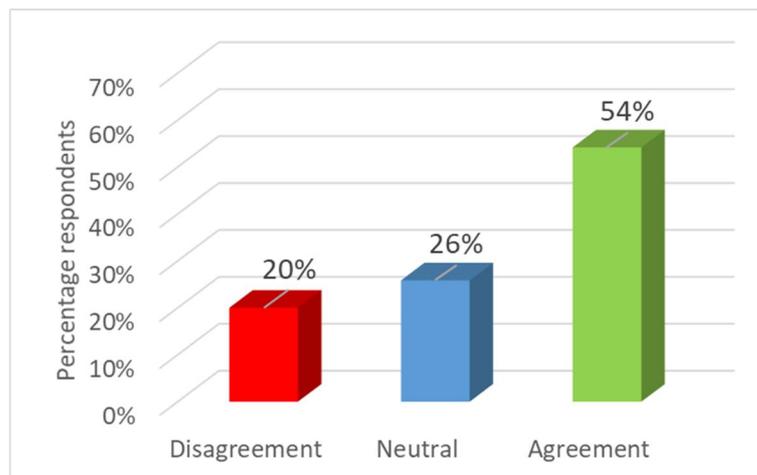


Figure 5.22: Cycle 2 respondents' perception of the *sense of community in the VCoP*.

In summary, although the combined non-negative responses for the perception of *learning through participation in the VCoP* (72%) and the perception of *member interaction in the VCoP* (89%) showed that Cycle 2 was successful in supporting these two traits, both traits showed combined agreement responses below 50%. Furthermore, the trait *learning through participation in the VCoP*, as well as the trait the perception of *a sense of community in the VCoP*, showed high disagreement responses at 28% and 20% respectively. The sub-themes therefore had to be analysed to gain a better understanding of the results, and to determine adaptations to Cycle 3.

5.3.2.5 Cycle 2 respondents' perception of sub-themes within learning through participation in the VCoP (Trait 1)

The results in Figure 5.23 show that there was a 50% agreement on the sub-theme *identifying with the profession in the VCoP*. There was also a strong combined non-negative

perception of 71%. Regarding the sub-themes *improving professional skills in the VCoP* and *acquiring new knowledge through participation in the VCoP*, their agreement responses were both 43% and their respective neutral responses were 30% and 29%. This suggested a non-negative perception of 73% for *improving professional skills in the VCoP* and a non-negative perception of 72% for *acquiring new knowledge through participation in the VCoP*. All three sub-themes showed high disagreement responses: *improving professional skills* (21%), *acquiring new knowledge* (24%) and *identifying with the profession* (25%). This meant that some action had to be taken in Cycle 3 to improve the existence of these three sub-themes.

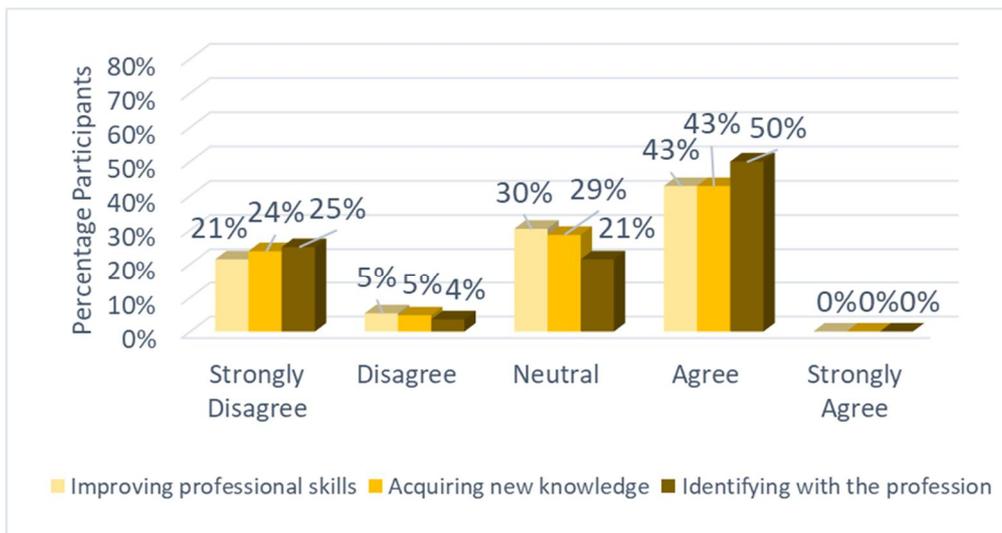


Figure 5.23: Cycle 2 respondents' perception of sub-themes within *learning through participation in the VCoP* (Trait 1).

5.3.2.6 Cycle 2 respondents' perception of sub-themes within member interaction in the VCoP (Trait 2)

In Figure 5.24 the results show that there were strong non-negative responses for both the sub-theme *collective problem solving in the VCoP* (92%) and the sub-theme *debating domain-related issues in the VCoP* (85%). Combining the disagreement responses for the latter sub-theme, 16% of respondents felt that domain-related issues were not debated³⁸. This meant that even more focus had to be placed in Cycle 3 on ensuring that domain-related issues were presented to the participants. Overall there were, however, more positive than negative perceptions of the existence of both these sub-themes in Cycle 2.

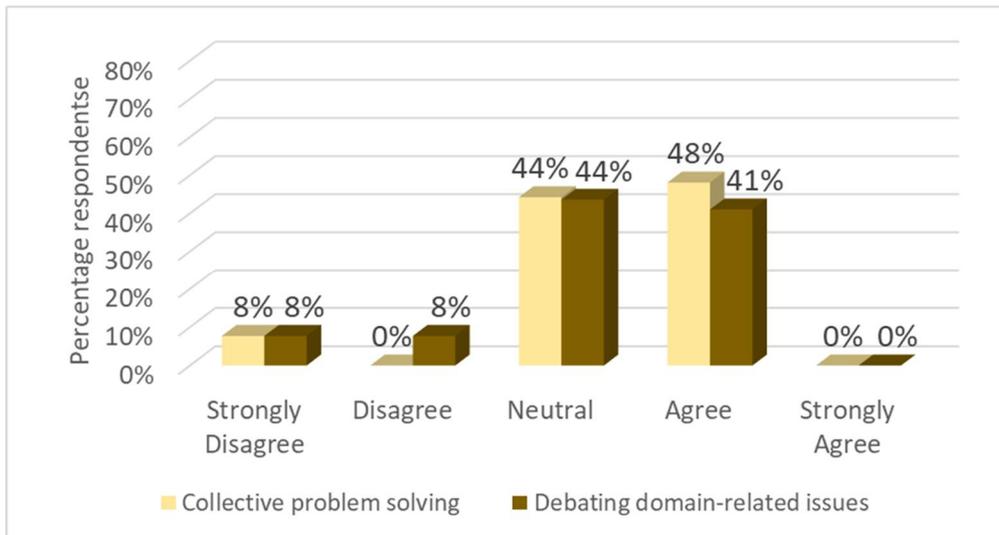


Figure 5.24: Cycle 2 respondents' perception of sub-themes within *member interaction in the VCoP* (Trait 2).

5.3.2.7 Cycle 2 respondents' perception of sub-themes within the use of WhatsApp group specific tools and standards in the VCoP (Trait 3).

The results in Figure 5.25 show that there was strong agreement on both the sub-themes *shared criteria in the VCoP* (50%) and *shared practices in the VCoP* (58%). These sub-themes also showed strong combined non-negative perceptions of 92% and 89% respectively. As for the combined disagreement responses, there was only an 8% combined disagreement level for shared criteria and an 11% combined disagreement level for shared practices. Cycle 2 was therefore effective in supporting both these sub-themes and no adaptations were required for Cycle 3.

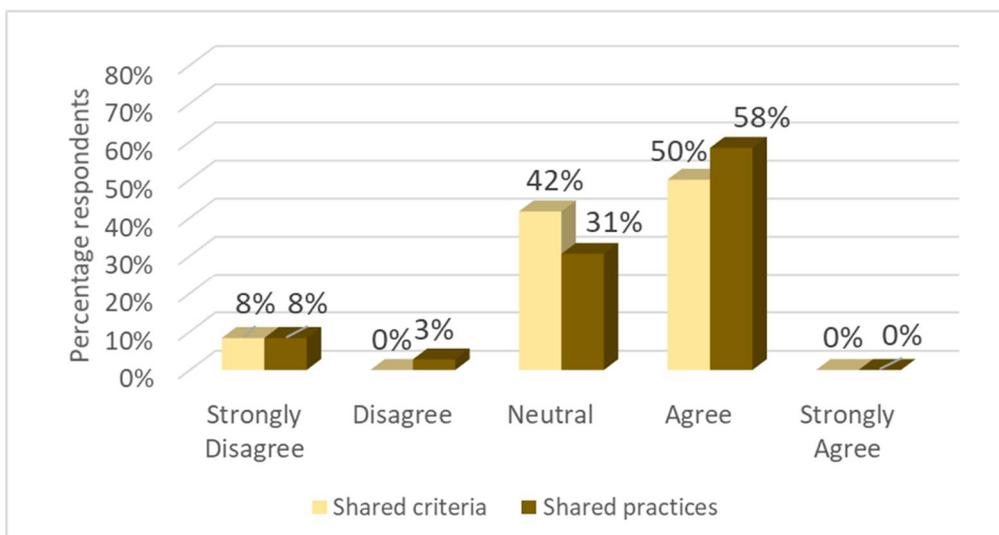


Figure 5.25: Cycle 2 respondents' perception of sub-themes within the *use of WhatsApp group specific tools and standards in the VCoP* (Trait 3).

5.3.2.8 Cycle 2 respondents' perception of sub-themes within a sense of professional community in the VCoP (Trait 4)

In Figure 5.26 the results show that there was strong agreement on both the sub-themes *shared sense of professional community in the VCoP* (57%) and *members' knowledge of each other in the VCoP* (52%). These sub-themes also showed strong combined non-negative perceptions of 87% and 74% respectively. Although there was a 26% combined disagreement perception of members' knowledge of each other in the VCoP, 52% of Cycle 2 respondents indicated that the members of the VCoP did get to know each other professionally. This represents a 16 percentage points increase from Cycle 1. As Cycle 2 participants resided in the sparsely populated Northern Cape Province of South Africa where they seldom had a chance to interact with one another, this result was seen as a positive VCoP outcome. Overall there were more positive than negative perceptions of both the Trait 4 sub-themes in the Cycle 2 VCoP.

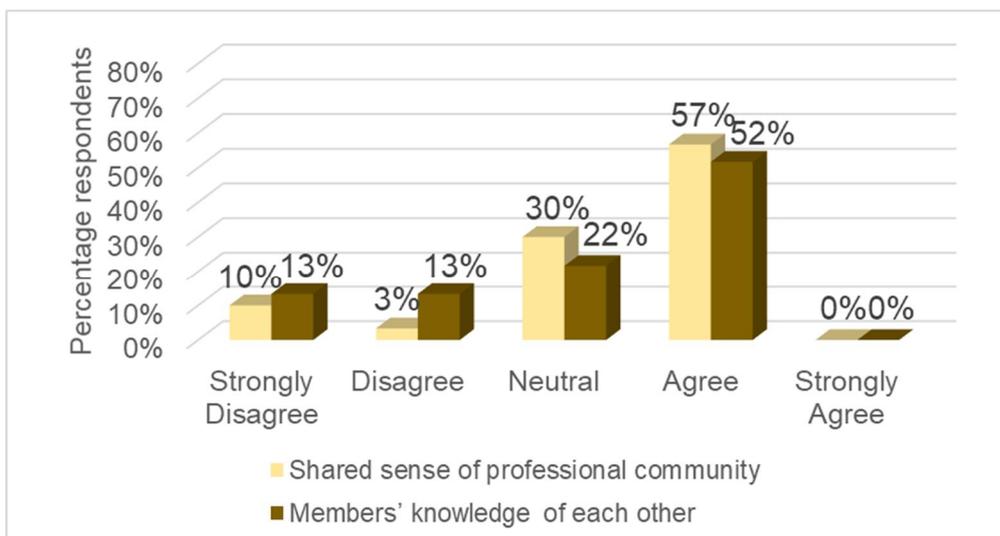


Figure 5.26: Cycle 2 respondents' perception of sub-themes within a sense of professional community in the VCoP (Trait 4)

5.3.2.9 Cycle 2 respondents' perception of caring for a domain of knowledge in a VCoP (Trait 5)

Ten out of the 12 respondents in the VCoP validation questionnaire completed the qualitative, open-ended question. Nine of these 10 respondents started their answers with a positive response such as "yes" (8) or "yez" (1). The tenth respondent did not indicate a single word yes or no response, but the answer was positive. As in Cycle1, this section of the study was led by specific themes, and the results were therefore deductively, thematically analysed (Crabtree & Miller, 1999; Fereday & Muir-Cochrane, 2006). The same themes and codes as for Cycle 1 were used: for the theme *VCoP can achieve a professional*

orientation, the code #professional_orientation was used, and for the theme *VCoP can maintain focussed discussion*, the code #focussed_discussion was used.

Professional orientation refers to participants mentioning in their answers that discussions of teaching practices or teacher professional learning (TPL) related topics took place in the WhatsApp group. Although the explanations were more of a general nature, three participants' answers mapped to professional orientation:

C2_Teacher 02³⁹: Especially teachers from underperforming schools gained insight

C2_Teacher 04: ...because we shared our best teaching practices.

C2_Teacher 10: ...new method of learning and interaction.

Focussed discussions refer to participants mentioning in their answer that TPL subject related content (Life Sciences teaching in Cycle 2) was discussed in the WhatsApp group. Two participants' answers mapped to focussed discussion:

C2_Teacher 03: ...because I felt that when-ever I had problems with the content, I could just ask freely and get an answer.

C2_Teacher 10: ...quick exchange of ideas and knowledge.

Only one participant had a distinctly negative response to the group as joint enterprise:

C2_Teacher 06: Was a bit not trusting it.

From the presence of these themes in the respondents' answers, it can be deduced that most respondents experienced the Cycle 2 WhatsApp group as a joint enterprise space. Consequently Cycle 2, a facilitated structured VCoP that aligned with the andragogical approach of self-directedness, was, just as Cycle 1, effective in supporting a joint enterprise space.

5.3.2.10 Summary of Cycle 2 respondents' perceptions of VCoP Traits 1 – 5

From the analysis of the VCoP validation questionnaire, Cycle 2, a facilitated structured VCoP that aligned with the andragogical approach of self-directedness, was effective in supporting all of Wenger's (1998) five essential traits for CoPs. When focussing on the sub-

³⁹ Participant names were anonymised. In Cycle 2 all participant pseudonyms start with C2.

themes, adaptations had to be made to Cycle 3, as all the *learning through participation in the VCoP* sub-themes, as well as the sub-theme *debating domain-related issues in the VCoP*, were perceived to be unsatisfactorily supported in Cycle 2. As an adaptation to Cycle 2, effort had been made to encourage more subject-topic knowledge debates in Cycle 2 than in Cycle 1. However, in the facilitated structured VCoP of Cycle 2, that aligned with the andragogical approach of self-directedness, participants' perception of *learning through participation in the VCoP* was lower than in the minimally structured VCoP of Cycle 1, that aligned with the heutagogical approach of self-determination. This led to an even more structured effort to encourage subject-topic knowledge debates in Cycle 3. The adaptations to Cycle 3 will be discussed in the following section.

5.3.2.11 Adaptations to the design of Cycle 3 regarding learning through participation in the VCoP and debating domain-related issues in the VCoP

In response to the formative evaluation of data collected from the VCoP validation instrument in Cycle 2, three strategies were put in place to address the challenges identified in the previous sections. All three strategies were linked to providing practice-based content from the TPL short course (design outcome 3), increasing teaching presence and supporting TSPCK.

5.3.2.12 Strategy 1: Regularly posted vignettes and quizzes

Vignettes and quizzes were posted to engage the participants with the topics, in order to encourage debating of domain-related issues and to enhance the acquisition of new knowledge. For Cycle 3, where Pittenger's (2013) highly structured format was followed, the vignettes or quizzes were aligned with the TPL short course topic sequence and posted once a week (Figure 5.27).

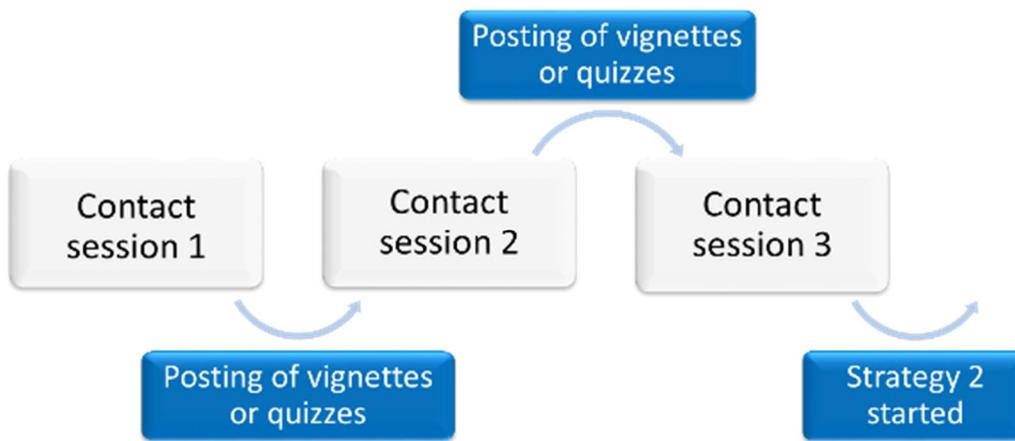


Figure 5.27: Diagrammatic representation of time frames of vignette or quiz posting during Cycle 3.

An example of a quiz posted during Cycle 3, can be seen in Figure 5.28.

1. 'n Elektron orbitaal (die stippellyne op die diagram) stel voor:

A. Die pad wat die elektrone om die kern/nukleus volg.

B. Die presiese afstand van 'n electron van die kern/nukleus.

C. 'n Drie-dimensionele (3D) spasie waar die elektrone hulself 90% van die tyd bevind.

🧠 Wanneer julle vandag 'n kansie het sal ek graag, groot asb, wil hê dat ELKEEN op die groep hierdie vragie beantwoord. Tik net A, B of C 😊.

10:55 ✓

1. An electron orbital (the dotted lines on the diagram) represents:

A. The path that the electrons followed around the nucleus.

B. The precise distance of the electron from the nucleus.

C. The three-dimensional (3D) space in which the electrons find themselves 90% of the time.

🧠 When you have some time today I would like to ask EACH one on the group to please answer this question. Only type A, B or C 😊.

Figure 5.28: Screenshot of a quiz posted by the researcher during Cycle 3⁴⁰.

5.3.2.13 Strategy 2: Regularly posted content explanatory video clips.

Another strategy to address and enhance participants' perception of *acquisition of new knowledge in the VCoP* was implemented in response to student requests after the third TPL contact session. During the contact session students voiced their fears about teaching

⁴⁰ Translation in text box on the right of the screenshot

one specific Natural Sciences topic, the balancing of chemical equations. Wagener (2006) shows that short video clips can provide a rich online learning experience, and Herrington, Oliver and Reeves (2016) comment that video clips enhance authenticity in online learning. Therefore, to enhance participants' acquisition of new knowledge, the researcher created short, content explanatory video clips. Borup, West and Graham (2012) pointed out that facilitator created video clips increase social presence of the facilitator in online platforms, which meant that uploading video clips also mapped to the social presence component of design outcome 1. The video clips focussed on the requested topic and ended with a question to the participants. This question consisted of an unbalanced chemical equation that they had to balance. The clips were posted once a week and participants were requested to send their answers privately to the researcher. This was done to give each participant a fair chance to attempt the question, without others seeing their answers or being influenced by other participants' answers. An example of screenshots from the posting of the first video clip can be seen in Figure 5.29, followed by screenshots from the video itself in Figures 5.30 and 5.31.

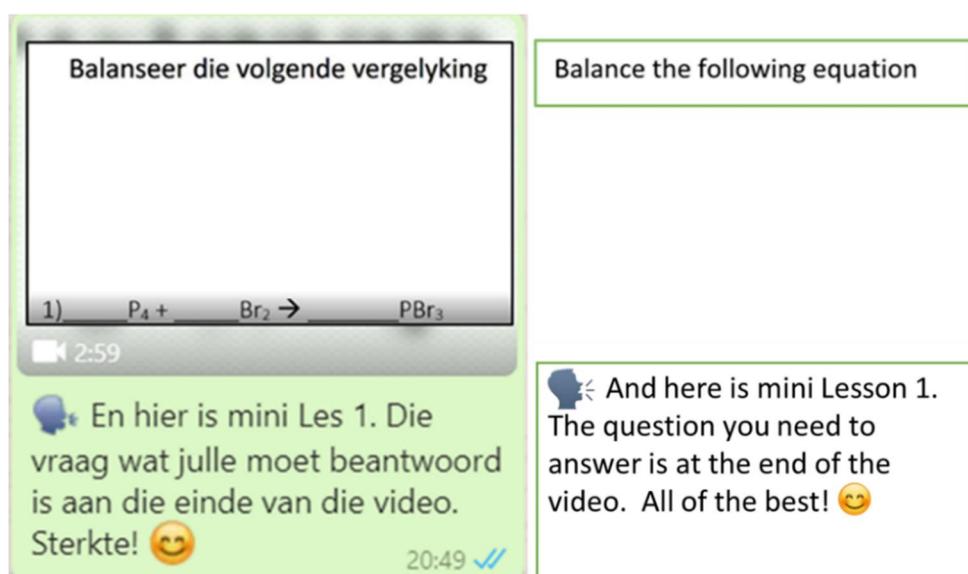


Figure 5.29: Screenshot of the message announcing the video clip posted by researcher in Cycle 3⁴¹.

⁴¹ Translation in text box on the right of the screenshot

<p>Balanseer die volgende vergelyking</p> <p>P = 4 Br = 2</p> <p>1) $\text{P}_4 + \text{Br}_2 \rightarrow \text{PBr}_3$</p>	<p>Balance the following equation</p>
<p>Balanseer die volgende vergelyking</p> <p>P = 4 Br = 2</p> <p>1) $\text{P}_4 + \text{Br}_2 \rightarrow 4 \text{PBr}_3$</p> <p>P = $1 \times 4 = 4$ Br = 3</p>	<p>Balance the following equation</p>

Figure 5.30: Screenshots of narrated video clip posted by researcher in Cycle 3.

<p>Balanseer die volgende vergelyking</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>MOENIE die antwoord op die GROEP sit nie. STUUR aan FASILITEERDER se Whatsapp. Ek sal antwoord op groep plaas sodra ten minste 8 antwoorde ontvang het.</p> </div> <p>2) $\text{CaF}_2 + \text{Na}_3\text{P} \rightarrow \text{NaF} + \text{Ca}_3\text{P}_2$</p>	<p>Balance the following equation</p> <p>DO NOT post the answer on the GROUP. SEND to FACILITATOR'S WhatsApp.</p> <p>I will post the answer on the group as soon as I have received at least 8 answers.</p>
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Figure 5.31: Screenshot of final screen of narrated video clip posted by researcher in Cycle 3⁴².

Participants would attempt to balance each week's equation on paper, take a photo of their answer and send it to the researcher in a private WhatsApp message. The researcher responded to the individual answers, informing the participants whether their answers were correct or not. At the end of the subsequent week, the researcher posted the next video clip on the group. This clip included a detailed, explanatory answer to the previous week's

⁴² Translation in text box on the right of the screenshot

question, as well as the new question. Participants were also prompted to comment on the group whether they were satisfied with the answer. Once again the affordance of Whatsapp as asynchronous communication tool was harnessed. A screenshot of a balanced equation answer by participant's C3_Teacher 03 can be seen in Figure 5.32.

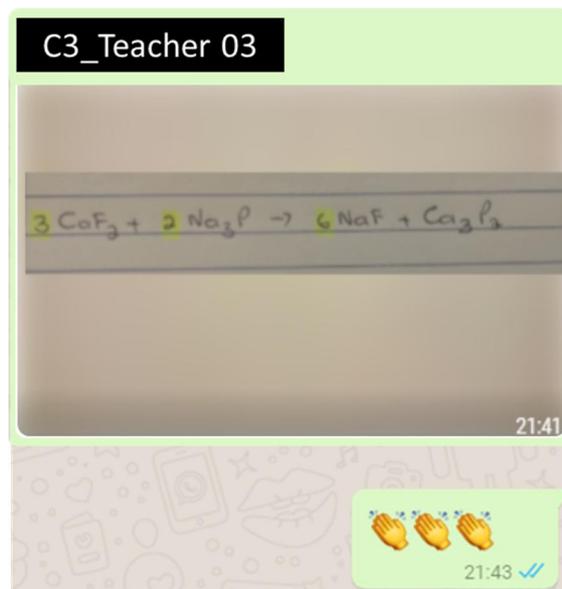


Figure 5.32: Screenshot of an answer posted during Cycle 3 by C3_Teacher 03 and the researcher response.

5.3.2.14 Strategy 3: Posting of participatory photos

To assist participants' perception of *identifying with the profession in the VCoP* (sub-theme 1C), participants were prompted to post their participatory photos during an online broadcast that formed part of the TPL course. Participants were also prompted to post their participatory photos during the support visits made by the TPL mentor. Veletsianos (2012, 2016) and Darling-Hammond, Wei, Andree, Richardson and Orpanos (2009) showed that, when individuals in professional occupations post images where they share their practices on social media, the group discussions usually show them identifying with their profession. During the online session, a lecture was broadcasted from SUNCEP, via the web conferencing platform Adobe Connect, to two venues that were relatively close to the participants' schools. The WhatsApp group of Cycle 3 functioned as a discussion platform for the broadcast. This allowed the researcher to formatively assess students' participation via their photos. The TPL mentor visited each participant at his or her school, where she sat in on at least one lesson. Participants had to present a lesson, linked to the TPL short course content, to their own learners. Most of the photographs of these lessons were taken

by the TPL mentor, as to not interrupt the flow of the lessons. Figure 5.33 is an example of such a lesson photo, posted after the lesson by a participant.

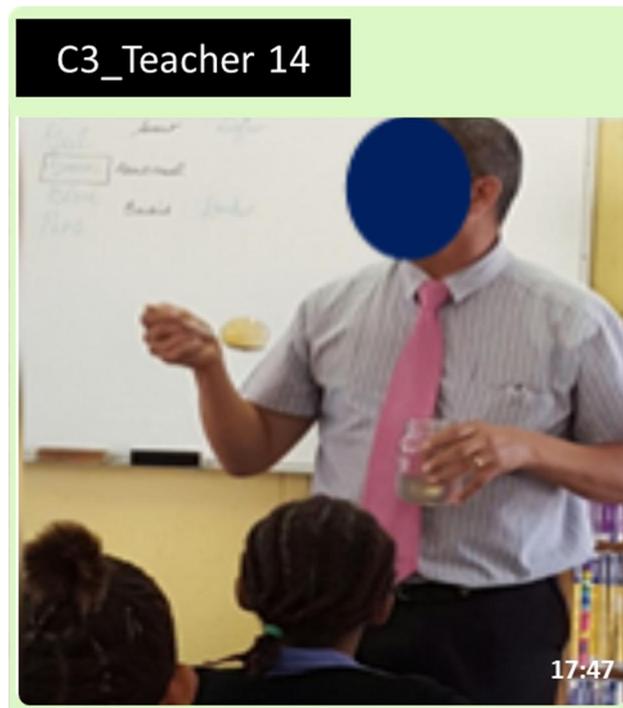


Figure 5.33: WhatsApp message screenshots of photo from own class practice, posted by C3_Teacher 14 in Cycle 3.

Participants in Cycle 3 were also discouraged from posting any off-topic (e.g. overtly social) WhatsApp messages. The researcher determined the extent of the success of these adaptations through the formative evaluation of Cycle 3. Cycle 3 is formatively evaluated in the next section. As it was the last cycle in this study, it did not inform a subsequent cycle, but it did inform sub-research question 1.

5.3.3 Formative evaluation of Cycle 3 in answer to research question 1

Cycle 3 was a highly structured VCoP in which researcher resource inputs were concept and time aligned with the TPL course (pedagogical approach of lecture determination). This cycle was effective as VCoP, with regard to the four Wenger (1998) essential traits that were quantitatively analysed, as the combined non-negative responses of each of the four associated Likert scale items were well above 50%. For *learning through participation in a VCoP* (Trait 1) the combined non-negative perception was 85%, compared to a 15% combined disagreement response. *Member interaction within the VCoP* (Trait 2) showed a combined non-negative perception of 83%, with a 17% combined disagreement response. The *use of group specific tools and standards in the VCoP* (Trait 3) had a combined non-

negative response of 93%, compared to an 8% combined disagreement response⁴³. The presence of *a sense of community in the VCoP* (Trait 4) showed a combined non-negative response of 86% compared to a 14% combined disagreement response. A more in-depth analysis of these results, ordered by essential traits, follows in the next sections.

5.3.3.1 Cycle 3 respondents' perception of learning through participation in the VCoP (Trait 1)

Cycle 3 showed the strongest combined agreement response (60%) across all cycles for *learning through participation in the VCoP* (Figure 5.34). Cycle 1 had the lowest combined agreement response at 45% followed by Cycle 2 at 52%. From the results in Figure 5.34, Cycle 3 also had a combined non-negative perception of 85%. Only 15% of the participants indicated that they felt that the VCoP did not contribute to their learning (combined disagreement response). Overall, Cycle 3 was therefore effective in supporting *learning through participation in the VCoP*. To inform sub-research question 1, the sub-themes for this trait are analysed in section 5.3.3.5.

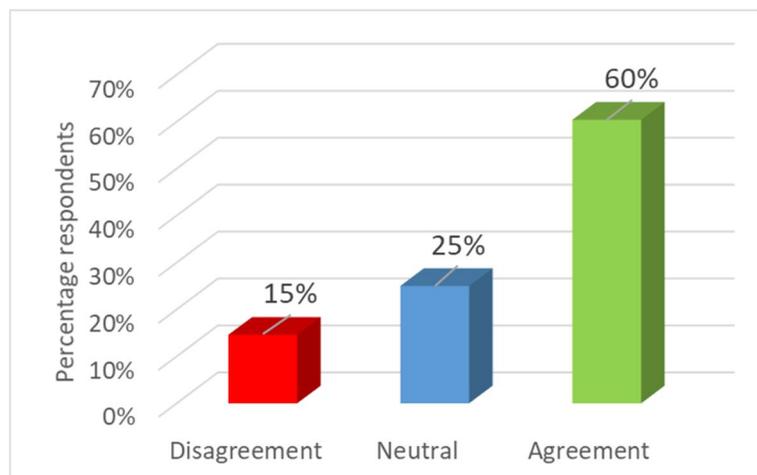


Figure 5.34: Cycle 3 respondents' perception of *learning through participation in the VCoP*.

5.3.3.2 Cycle 3 respondents' perception of member interaction in the VCoP (Trait 2)

The results in Figure 5.35 show an 83% combined non-negative perception of *member interaction in the VCoP*. However, this trait registered a low 36% combined agreement rate and a combined disagreement level of 17%. The sub-themes for member interaction in the

⁴³ All percentages were rounded to zero decimal places creating certain scenarios where it may appear as if the sum of data sample percentages may be less, or more than 100%. When the data is however viewed to more decimal places this discrepancy disappears.

VCoP therefore needed to be evaluated to inform sub-research question 1, as well as possible subsequent cycles in studies resulting from this dissertation (section 5.3.3.6).

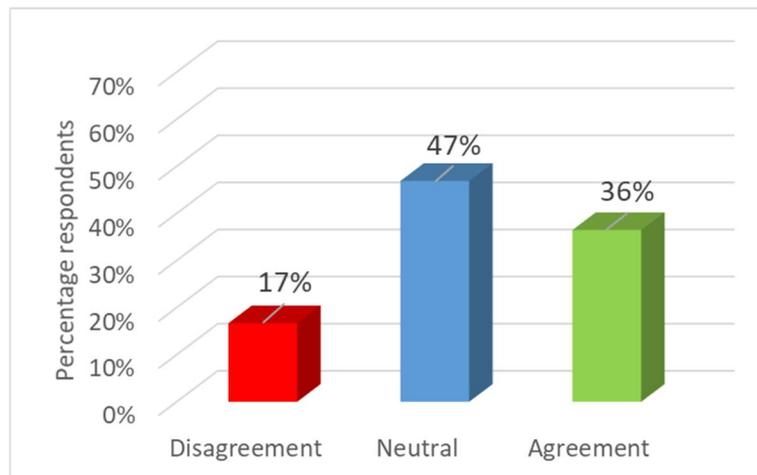


Figure 5.35: Cycle 3 respondents' perception of *member interaction in the VCoP*.

5.3.3.3 Cycle 3 respondents' perception of the use of WhatsApp group specific tools and standards in the VCoP (Trait 3)

The results in Figure 5.36 show a 93% combined non-negative perception of the *use of WhatsApp group specific tools and standards in the VCoP*. The combined disagreement level was low at 8%. However, this trait registered a low 38% combined agreement rate. The sub-themes for the perception of the *use of WhatsApp group specific tools and standards in the VCoP* therefore needed to be evaluated to inform sub-research question 1 and possible subsequent cycles in studies resulting from this dissertation (section 5.3.3.7).

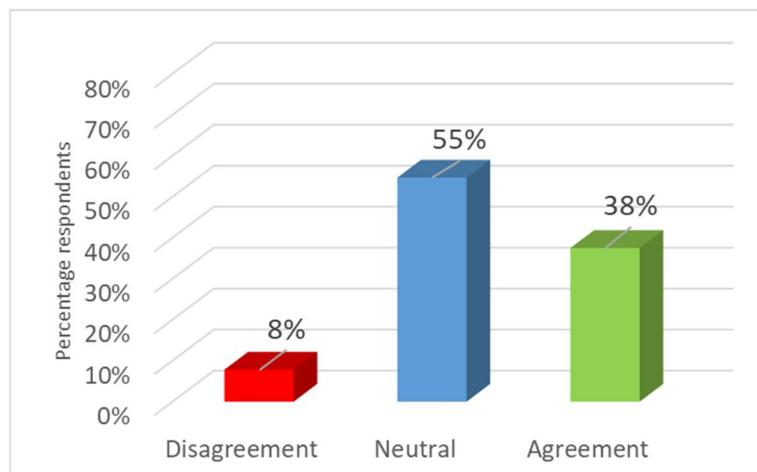


Figure 5.36: Cycle 3 respondents' perception of the *use of WhatsApp group specific tools and standards in the VCoP*.

5.3.3.4 Cycle 3 respondents' perception of a sense of community in the VCoP (Trait 4)

In Figure 5.37 the results show an 86% combined non-negative perception of a *sense of community in the VCoP*. However, this trait registered a 41% combined agreement rate and a 14% combined disagreement response. The sub-themes for the perception of a *sense of community in the VCoP* therefore needed to be evaluated to inform sub-research question 1 and possible subsequent cycles in studies resulting from this dissertation (section 5.3.3.8).

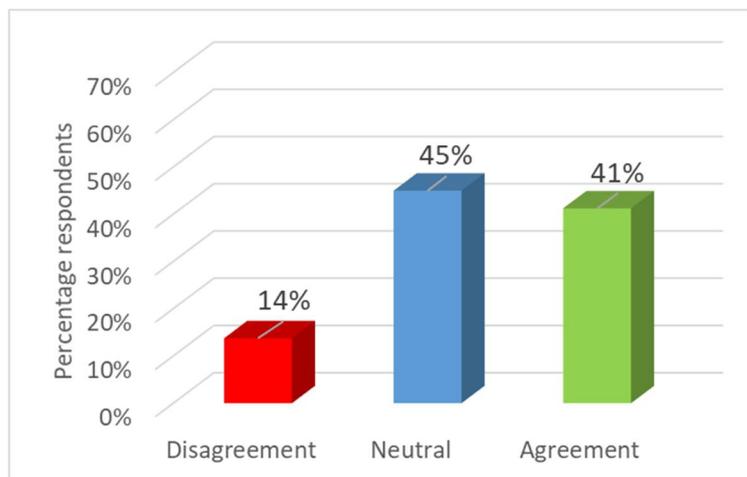


Figure 5.37: Cycle 3 respondents' perception of the presence of a *sense of community in the VCoP*.

The combined non-negative responses of the traits, the perception of *member interaction in the VCoP* (83%), the perception of the *use of WhatsApp group specific tools and standards in the VCoP* (93%) and the perception of a *sense of community in the VCoP* (86%) showed that Cycle 3 was effective in supporting these three traits. These traits, however, showed combined agreement responses below 50%. Furthermore, three traits showed worrying combined disagreement responses: *learning through participation in the VCoP* (15%), *member interaction in the VCoP* (17%) and perception of a *sense of community in the VCoP* (14%). The sub-themes of the four traits (linked to the Likert scale questions) therefore had to be evaluated to gain a better understanding of the results, and to inform sub-research question 1, as well as possible subsequent cycles in studies resulting from this dissertation.

5.3.3.5 Cycle 3 respondents' perception of sub-themes within learning through participation in the VCoP (Trait 1)

The results in Figure 5.38 show that there was very strong agreement on the sub-themes *improving professional skills in the VCoP* (63%) and *acquiring of new knowledge in the VCoP* (75%). These sub-themes also showed combined non-negative perceptions of 85%

and 88% respectively. Regarding the sub-theme about respondents *identifying with the teacher profession in the VCoP* there was 44% agreement and 41% neutral responses, suggesting a combined non-negative perception of 85% on this sub-theme. Furthermore, the latter theme, apart from registering a lower agreement rate, also registered a combined disagreement level of 16%, of which 3% registered as strong disagreement. In any subsequent studies, adaptations to improve members' perception of identifying with the profession could be tested. Overall there were, however, more positive than negative perceptions of the existence of all three sub-themes in the VCoP in Cycle 3.

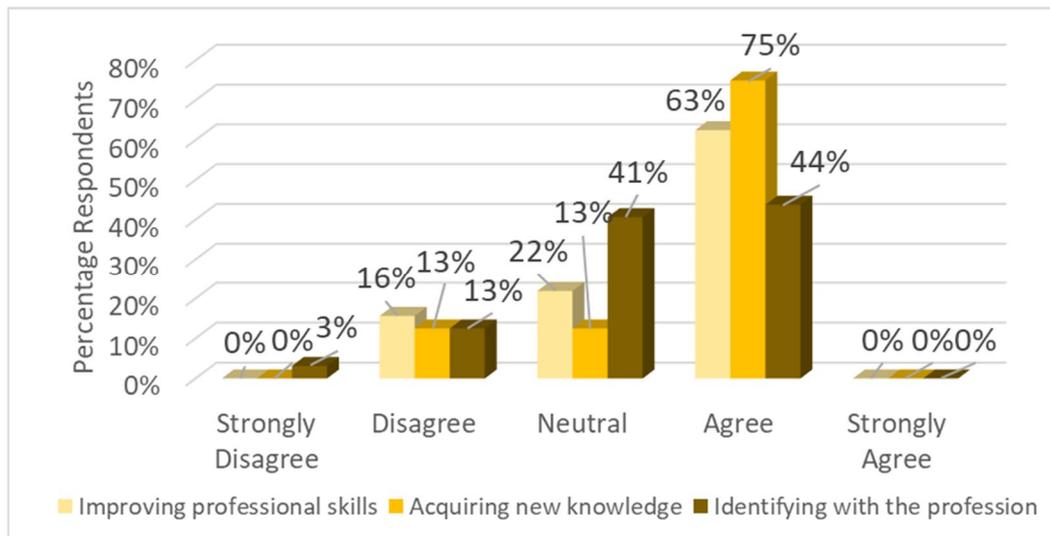


Figure 5.38: Cycle 3 respondents' perception of sub-themes within *learning through participation in the VCoP* (Trait 1).

5.3.3.6 Cycle 3 respondents' perception of sub-themes within member interaction in the VCoP (Trait 2)

In Figure 5.39 the results show that there was an 88% non-negative perception of *collective problem solving in the VCoP* and a 79% non-negative perception of the *domain-related issues were debated in the VCoP* sub-theme. Although even more strategies to encourage participants to engage in *debating domain-related issues in the VCoP* (sub-theme 2B) were employed in Cycle 3 than in either Cycle 1 or 2, only 29% of Cycle 3 respondents agreed that domain-related issues were satisfactorily debated in the VCoP, while the combined disagreement level was 21%. In any subsequent studies, adaptations to improve *debating domain-related issues in the VCoP* could be tested. Overall there were, however, more positive than negative perceptions of the existence of both the sub-themes in Cycle 3's VCoP.

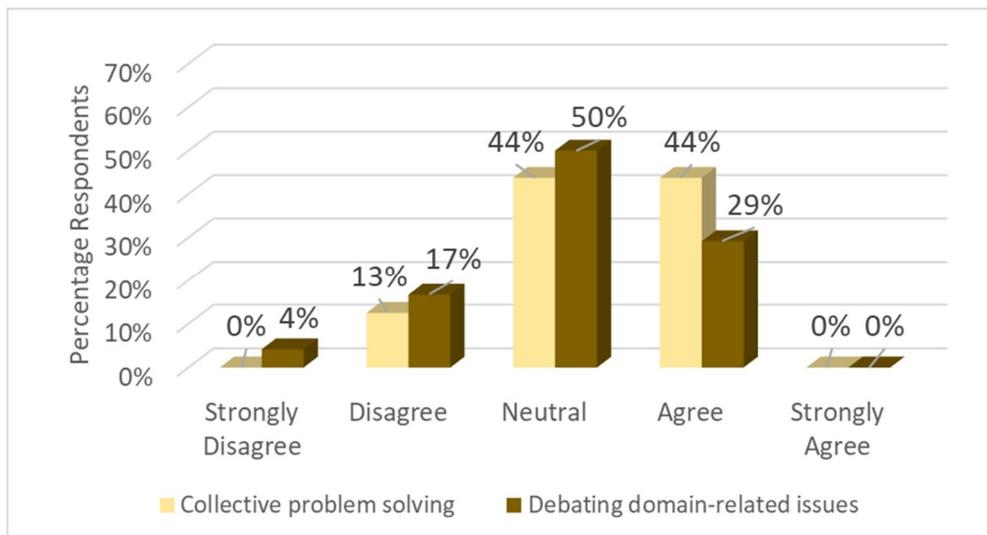


Figure 5.39: Cycle 3 respondents' perception of sub-themes within *member interaction in the VCoP* (Trait 2).

5.3.3.7 Cycle 3 respondents' perception of sub-themes within the use of WhatsApp group specific tools and standards in the VCoP (Trait 3)

The results in Figure 5.40 show that there was a 97% non-negative perception of the existence of *shared criteria in the VCoP* and an 88% non-negative perception of the existence of *shared practices in the VCoP* of Cycle 3. However, both sub-themes registered a low agreement rate of 38%. The combined disagreement perception for the existence of *shared criteria in the VCoP* was a low 3%, while the combined disagreement perception for the existence of *shared practices in the VCoP* were only 12%. In any subsequent studies adaptations to improve members' perception of *identifying with the profession in the VCoP* could be tested. Overall there were, however, more positive than negative perceptions of the existence of both the sub-themes in Cycle 3's VCoP.

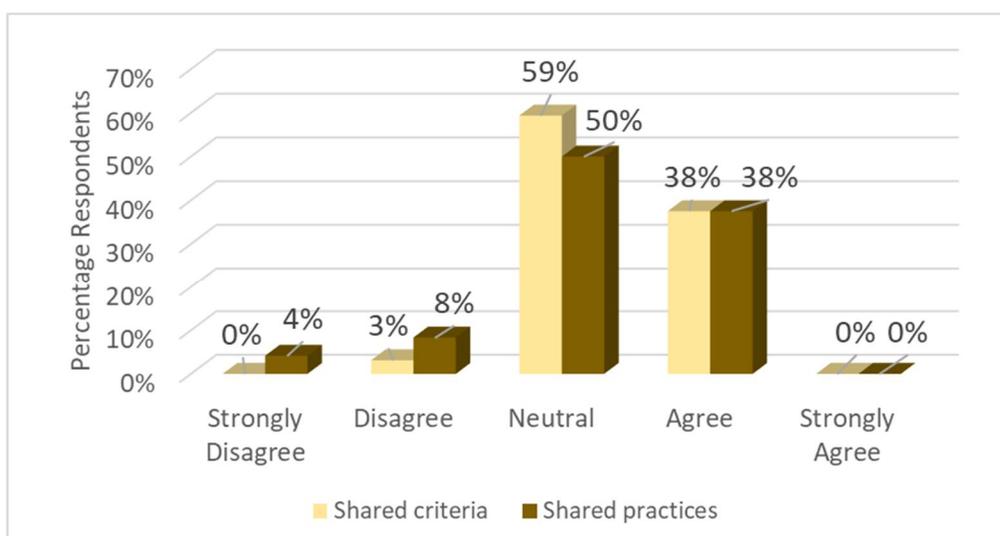


Figure 5.40: Cycle 3 respondents' perception of sub-themes within the *use of WhatsApp group specific tools and standards in the VCoP* (Trait 3).

5.3.3.8 Cycle 3 respondents' perception of sub-themes within a sense of community in the VCoP (Trait 4)

In Figure 5.41 the results show that, for Cycle 3, there was a 95% non-negative perception of the existence of a *shared sense of professional community in the VCoP* and a 78% non-negative perception of *members' knowledge of each other in the VCoP*. The agreement response for a *shared sense of professional community in the VCoP* was 45% and this sub-theme's combined disagreement level was a low 5%. Regarding the sub-theme *members' knowledge of each other*, there was a lower agreement rate of 38% and this sub-theme registered a combined disagreement level of 23%. In any subsequent studies, adaptations to improve both these sub-themes could be tested. Overall there were, however, more positive than negative perceptions of the existence of both the sub-themes in Cycle 3's VCoP.

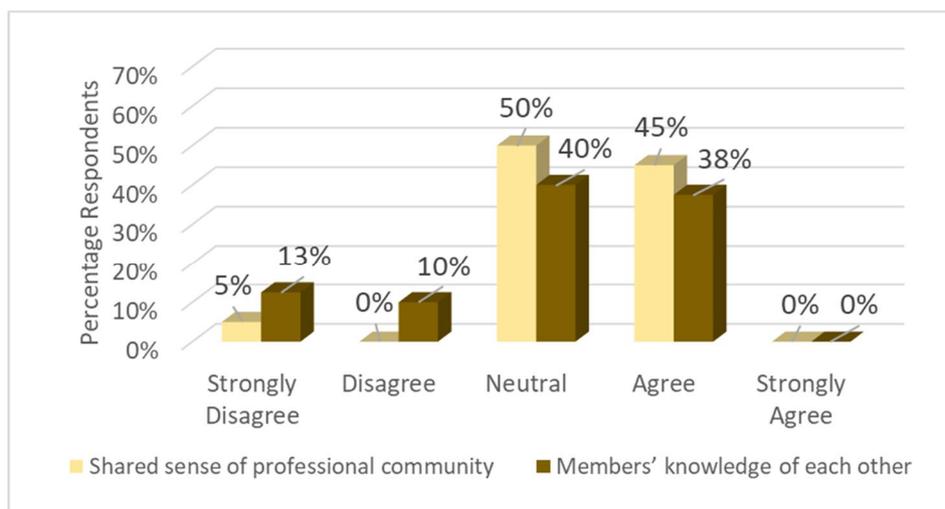


Figure 5.41: Cycle 3 respondents' perception of sub-themes within a sense of community in the VCoP (Trait 4).

5.3.3.9 Cycle 3 respondents' perception of caring for a domain of knowledge or joint enterprise in the VCoP (Trait 5)

All 8 respondents in the VCoP validation questionnaire completed the qualitative, open-ended question. Five respondents started their answers with the single word, positive response "yes" and one respondent answered both yes and no, with an explanation. Two respondents did not indicate a single word yes or no response. As in Cycle 1, this section of the study was led by specific themes, and it was therefore deductively, thematically analysed (Crabtree & Miller, 1999; Fereday & Muir-Cochrane, 2006). The same themes and codes as for Cycle 1, were used: for the theme, the *VCoP can achieve a professional orientation*,

the code #professional_orientation was used and for the theme, the *VCoP can maintain focussed discussion*, the code #focussed_discussion was used.

Professional orientation refers to participants mentioning in their responses that discussions of teaching practices or teaching professional learning (TPL) related topics took place in the WhatsApp group. Although the group functioned in Afrikaans, some of the respondents answered the qualitative question in English.

C3_Teacher 01⁴⁴: This WhatsApp group brought meaning to "community of learning". I felt comfortable to ask questions and even give answers. Members treated each other with respect and professionalism and within seconds facilitators responded to our texts.

C3_Teacher 06: I view the WhatsApp group as community of learning as teachers share their needs, best practices and experiences and through electronic interaction learning happened.

Focussed discussions refer to participants mentioning in their responses that TPL subject related content (Natural Sciences teaching in Cycle 3) was discussed in the WhatsApp group, e.g.

C3_Teacher 02: Ek het verskriklik baie geleer deur die Whatsapp. Sekere goed wat nie by die face-to-face sessies aangespreek of genoem was nie het ons op die groep bespreek [Translation: I learned such a lot from the WhatsApp. Certain things that were not addressed or spoken about at the face-to-face sessions were discussed on the group]

C3_Teacher 08: If I had questions about the course or subject, the members of the group kindly assisted me.

C3_Teacher 07 answered both yes and no. On the positive side this participant felt that "In meeste gevalle kan dit vir leer gebruik word" [Translation: In most cases it can be used for learning], which could be seen as a reference to focussed discussion. On the flip side this participant was of the opinion that the group, although consisting of only 15 participants, was too large.

From the presence of both of the *a priori* themes in the respondents' answers, it can be deduced that most respondents experienced the Cycle 3 WhatsApp group as a joint

⁴⁴ Participant names were anonymised. In Cycle 3 all participant pseudonyms start with C3.

enterprise space and consequently that Cycle 3 was effective in supporting a joint enterprise space.

5.3.3.10 Summary of respondents' perceptions of the existence of essential traits in the VCoP in Cycle 3.

Following the analysis of the VCoP validation questionnaire, Cycle 3, a highly structured VCoP that aligned with the pedagogical approach of lecture determination, succeeded in supporting all of Wenger's (1998) five essential traits of CoPs. Focussing on the sub-themes, Cycle 3 participants were of the perception that the sub-themes *debating domain-related issues in the VCoP* and *members' knowledge of each other in the VCoP* still needed improvement. In any subsequent studies, testing of adaptations to improve the presence of these sub-themes is recommended.

5.3.3.11 Summary of the initial evaluation (Layer A)

Layer A of the data analysis of the three iterative DBR cycles in this study comprised of formative evaluation of the data collected by means of the context adapted Murillo's (2008) CoP validation survey instrument. As an initial answer to sub-research question 1, all three cycles generally supported all of Wenger's (1998) five essential traits of CoPs, as each cycle's combined non-negative responses were well above 50%. However, the sub-theme that consistently showed agreement responses below 50% was *debating domain-related issues in the VCoP*. To gain a deeper understanding of the quantitative data, and to better inform sub-research question 1, a summative, retrospective comparison of the three cycles' effectiveness as VCoPs is presented next.

5.4 The bird's-eye view summative, retrospective comparison (Layer B)

This retrospective comparison aims to provide a more in-depth evaluation of the data from all three cycles. Therefore, each trait's combined disagreement responses (strongly disagree and disagree), neutral responses and combined agreement responses (strongly agree and agree) were compared between all three cycles. The aim was to rank the three cycles regarding their initial effectiveness in fostering the four Wenger (1998) essential traits of CoPs that were quantitatively analysed.

5.4.1.1 Learning through participation in the VCoP (Trait 1)

The results in Figure 5.42 show that Cycle 3 respondents, at 60%, had the highest perception rate of all three cycles for *learning through participation in the VCoP*. Cycle 3 also registered the lowest neutral response rate (25%) and the second lowest combined disagreement response rate (15%). Cycle 3 was therefore the most effective in fostering learning through participation in the VCoP. Cycle 2 registered the lowest combined agreement response rate (45%) across all three cycles and the highest combined disagreement response rate of 28%. Cycle 2 respondents therefore perceived their VCoP to be the least effective in supporting learning through participation in the VCoP.

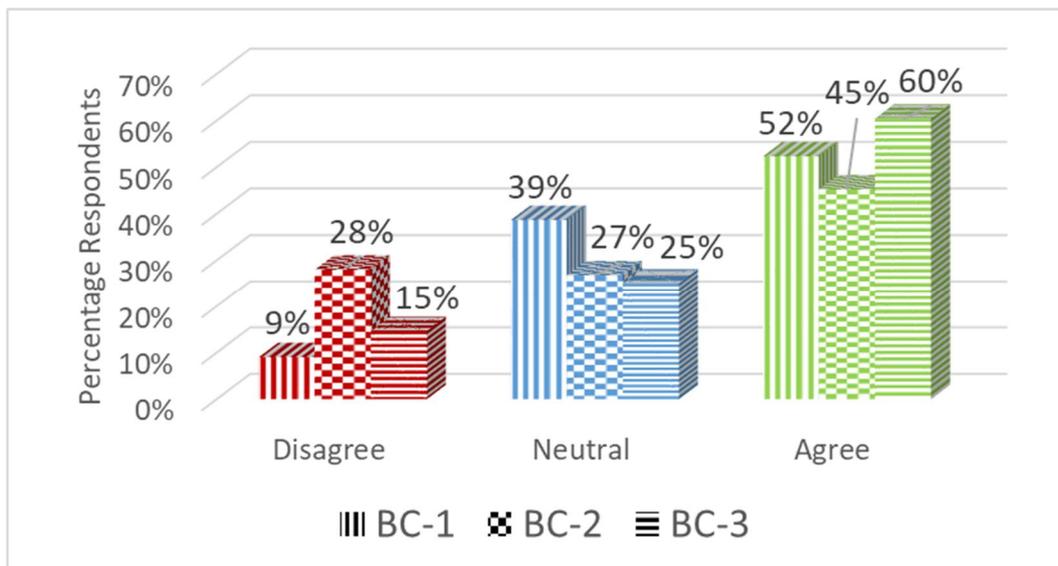


Figure 5.42: Cycles 1 to 3 respondents' perception of *learning through participation in the VCoP*.

The rank order of cycle initial effectiveness in *fostering learning through participation in the VCoP* is therefore 1st Cycle 3, 2nd Cycle 1 and 3rd Cycle 2 (Figure 5.43).

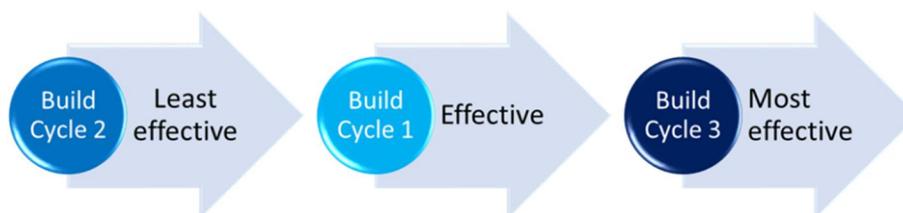


Figure 5.43: Comparison of the different cycles regarding effectiveness in fostering *learning through participation in the VCoP*.

5.4.1.2 Member interaction in the VCoP (Trait 2)

In Figure 5.44 the results show that Cycle 1 respondents, at 48%, perceived the highest level of *member interaction in the VCoP* of all three cycles. Cycle 1 respondents also registered the lowest combined disagreement response (11%). The combined agreement response of Cycle 2 was 45% and the combined disagreement response 12%. This infers that those respondents had only a slightly lower perception of *member interaction in the VCoP* than Cycle 1 respondents. Cycle 3 respondents had the lowest perception of *member interaction in the VCoP*, registering both the lowest combined agreement (36%) and highest combined disagreement (17%) responses. A comparison between the structure of each VCoP and their respondents' perception of *member interaction in the VCoP* shows a plausible explanation. Cycle 1 was the minimally structured VCoP and members were allowed to post both academic and socially orientated messages. Cycle 2 had a facilitated structured VCoP and Cycle 3 a highly structured VCoP. In both Cycles 2 and 3, members were encouraged to refrain from posting socially orientated messages. It would seem that the more structured and academically focussed the VCoP became, respondents' perception of *member interaction in the VCoP* lowered.

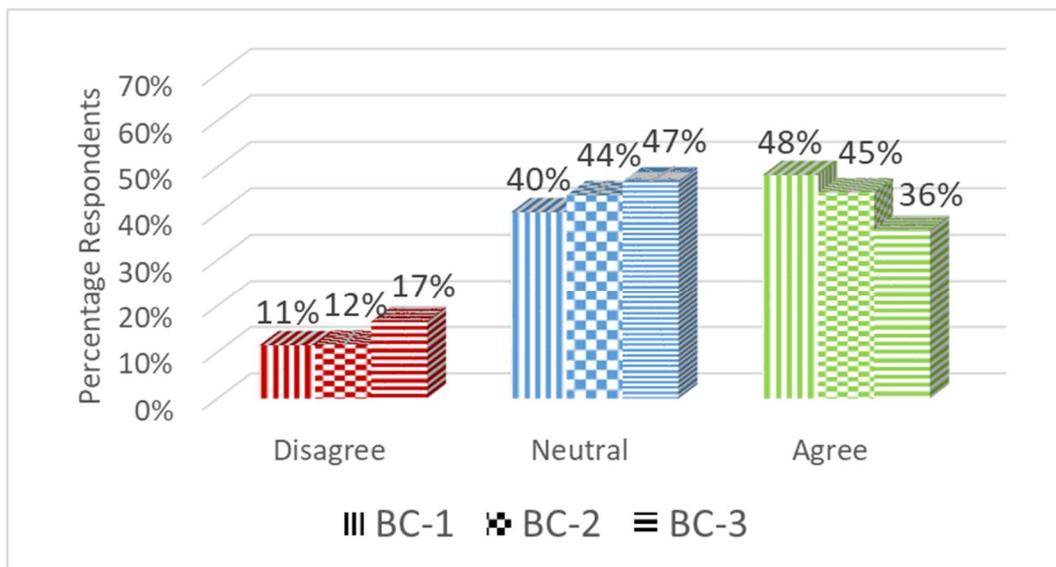


Figure 5.44: Cycles 1 to 3 respondents' perception of *member interaction in the VCoP*.

The rank order of cycle effectiveness regarding initial effectivity in fostering *member interaction in the VCoP* is therefore 1st Cycle 1, 2nd Cycle 2 and 3rd Cycle 3 (Figure 5.45).

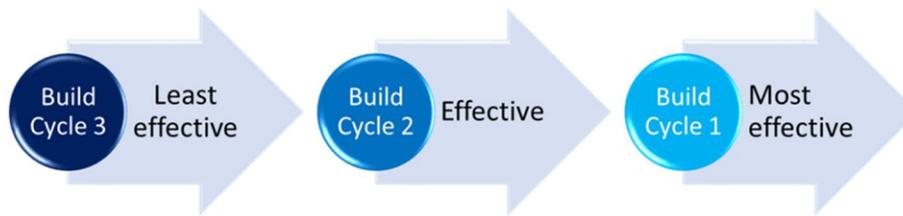


Figure 5.45: Comparison of the different cycles regarding effectiveness in fostering the perception of *member interaction in the VCoP*.

5.4.1.3 Use of WhatsApp group specific tools and standards in the VCoP (Trait 3)

The results in Figure 5.46 show that there was a strong 54% combined agreement response in Cycle 2 on the *use of WhatsApp group specific tools and standards in the VCoP*. Cycle 2 respondents also registered the lowest neutral response rate (36%) across all three cycles. Of all three cycles, Cycle 2 respondents therefore perceived the highest rate of the *use of WhatsApp group specific tools and standards in the VCoP*. When comparing the results of Cycle 1 with those of Cycle 3, Cycle 1 respondents had the strongest combined agreement perception (44%) and the lowest combined disagreement perception (4%) regarding the *use of WhatsApp group specific tools and standards in the VCoP*. This placed Cycle 1 second behind Cycle 2.

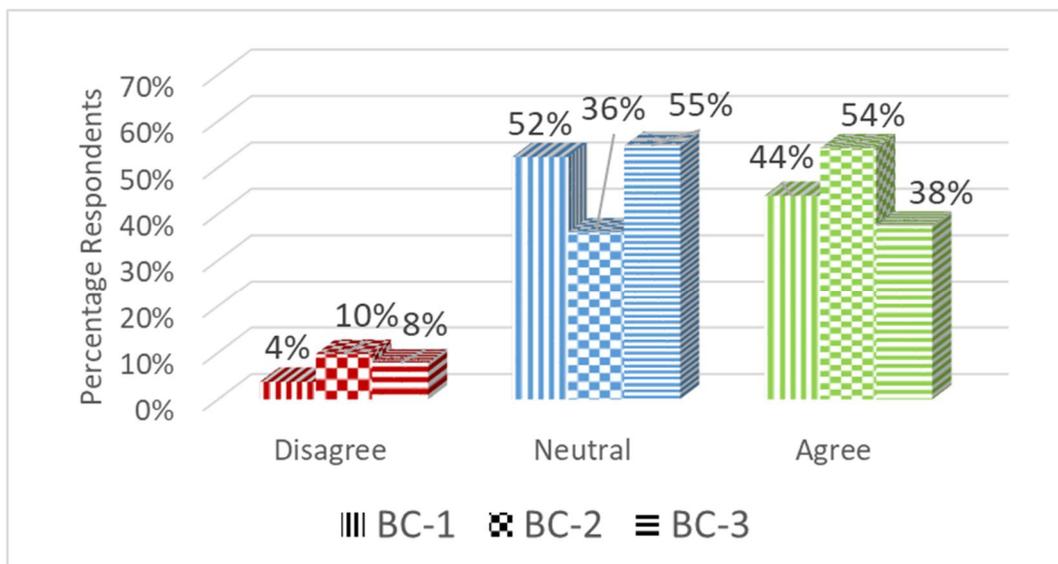


Figure 5.46: Cycles 1 to 3 respondents' perception on the *use of WhatsApp group specific tools and standards in the VCoP*.

The rank order of cycle effectiveness regarding initial effectivity in fostering the *use of WhatsApp group specific tools and standards in the VCoP* is therefore 1st Cycle 2, 2nd Cycle 1 and 3rd Cycle 3 (Figure 5.47).

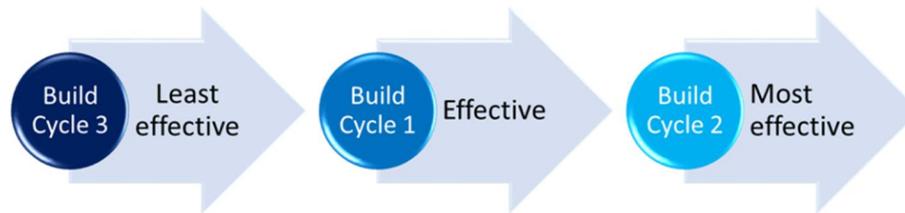


Figure 5.47: Comparison of the different cycles regarding effectiveness in fostering the perception of the *use of WhatsApp group specific tools and standards in the VCoP*.

5.4.1.4 Sense of community in the VCoP (Trait 4)

In Figure 5.48 the results show that, across all cycles for this trait, Cycle 2 respondents, at 54%, perceived the highest *sense of community in the VCoP*. Cycle 2 also registered the lowest neutral response rate (26%). When comparing the results of Cycle 1 with those of Cycle 3, Cycle 1 respondents showed the strongest combined agreement perception (51%) of a *sense of community in the VCoP*. In addition, less Cycle 1 respondents (34%) than Cycle 3 respondents (45%) felt neutral about this trait. Cycle 1 therefore ranked second in fostering a *sense of community in the VCoP* behind Cycle 2.

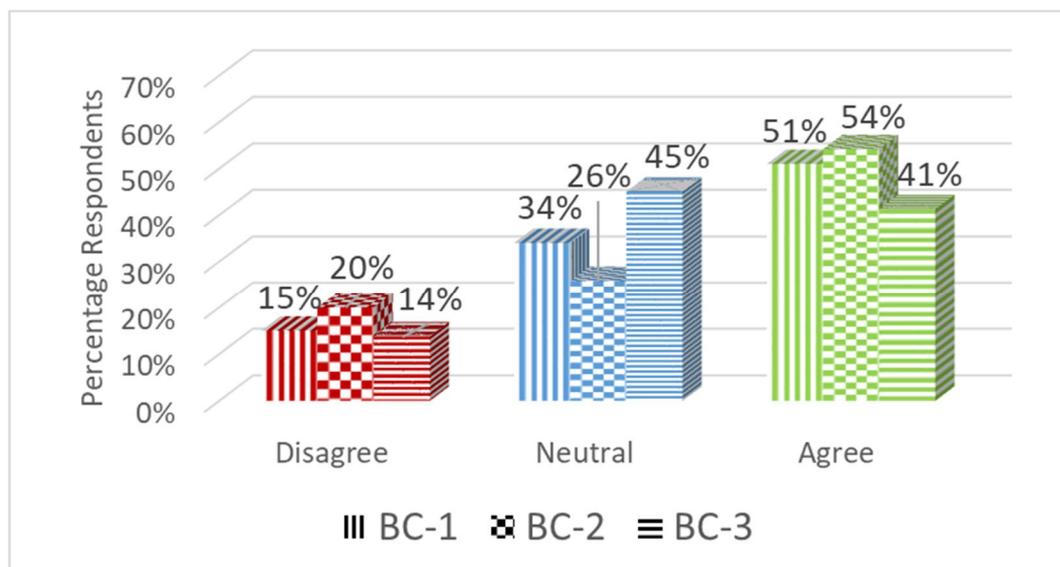


Figure 5.48: Cycles 1 to 3 respondents' perception of the presence of a *sense of community in the VCoP*.

The rank order of cycle effectiveness regarding initial effectivity in fostering *member interaction in the VCoP* is therefore 1st Cycle 2, 2nd Cycle 1 and 3rd Cycle 3 (Figure 5.49).

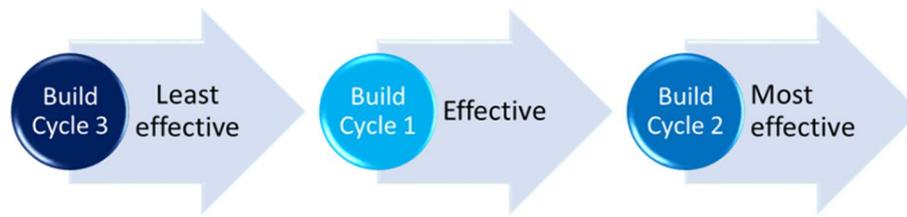


Figure 5.49: Comparison of the different cycles regarding success in fostering the presence of a *sense of community in the VCoP*.

5.4.1.5 Summary of retrospective comparison of essential traits (Layer B)

Sub-research question 1 asked: Which essential traits of a virtual community of practice (VCoP) were fostered in each WhatsApp VCoP? During the formative evaluation, Layer A, this question was broadly answered in that all three cycles fostered all Wenger's (1998) essential traits of CoPs. To provide a more in-depth answer, a summative, retrospective comparison of essential traits across cycles, Layer B, was performed. The three cycles were then ranked as to their effectiveness in fostering each of the four Wenger (1998) essential traits that were quantitatively analysed. In Figure 5.50 it can be seen that Cycle 3 was most conducive in fostering *learning through participation in the VCoP* (Trait 1). Cycle 1 was most effective in fostering *member interaction in the VCoP* (Trait 2). Cycle 2 was most effective in fostering both the *use of WhatsApp group specific tools and standards in the VCoP* (Trait 3) and *a sense of community within the VCoP* (Trait 4). Through the use of a simple scoring system, where 3 points are allocated for first place, two for second place and 1 for third place, it was determined that Cycles 1 and 2 competed for overall honours as the most effective VCoP. However, since Cycle 2 ranked first in two of the traits, it was deemed to be the most effective VCoP. In Layer C, the nitty gritty, the summative, retrospective evaluation of each trait is further analysed to determine respondents' perceptions of VCoP success at sub-theme level.

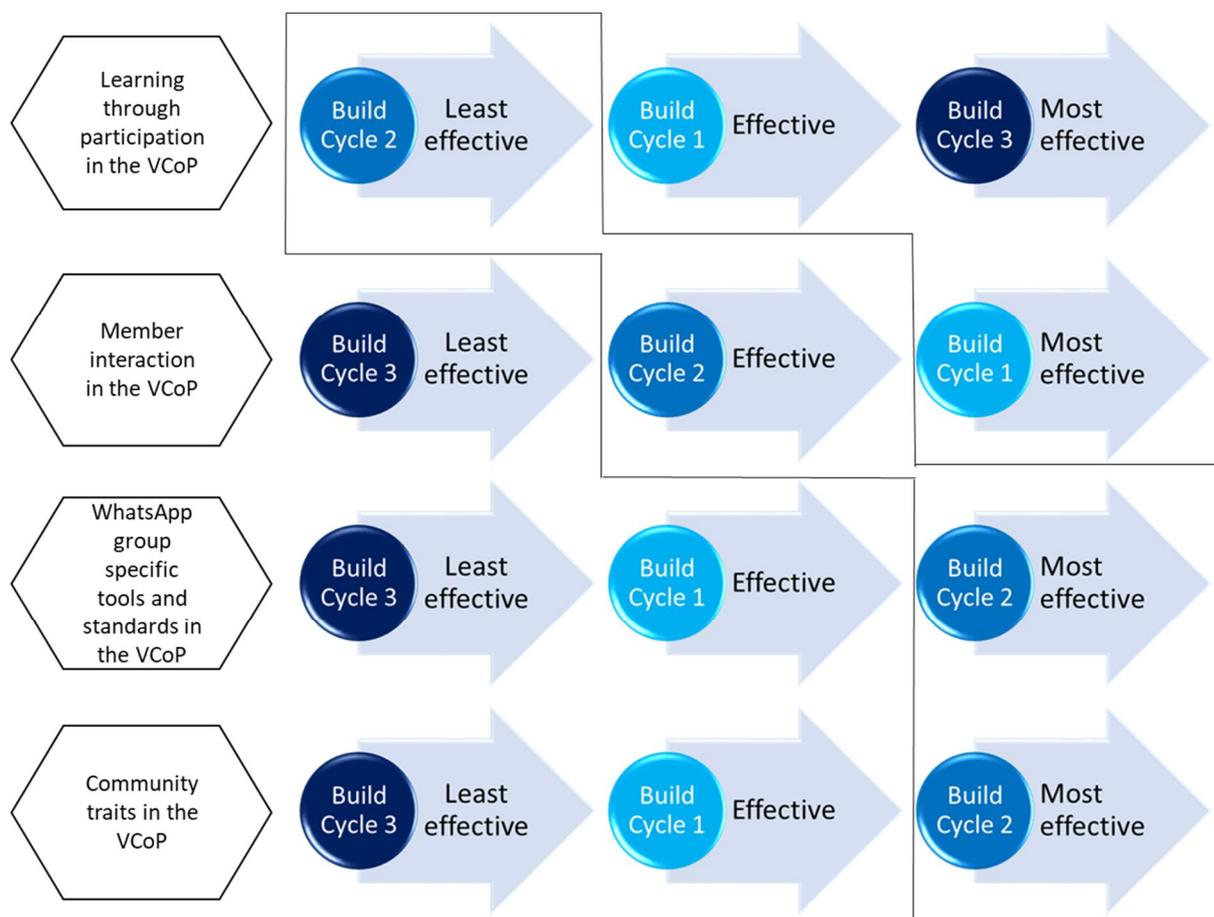


Figure 5.50: Comparison of the different cycles regarding success in fostering all four essential traits.

5.5 The nitty gritty retrospective evaluation (Layer C)

This second summative, retrospective comparison aims to achieve an even more in-depth evaluation of the data from all three cycles. Therefore, each trait's sub-themes were compared by cycle, by evaluating all of the Likert scale items. The aim was to rank the three cycles regarding their effectiveness in fostering Murillo's (2008) sub-themes within the Wenger (1998) four essential traits of CoPs that were quantitatively analysed.

5.5.1.1 Improving professional skills in the VCoP (Trait 1, Sub-theme 1A)

The results in Figure 5.51 show that there was a strong agreement response (63%) in Cycle 3 on respondents' perception of the *improvement of professional skills in the VCoP*. Cycle 3 also registered the second lowest disagreement level of 16%. Therefore, Cycle 3 was the most effective in fostering the sub-theme *improvement of professional skills in the VCoP*. Cycle 2 not only registered the lowest agreement response (43%), but it also showed the highest strongly disagree response at 21%. This made Cycle 2 the least effective cycle in terms of fostering *improvement of professional skills in the VCoP*.

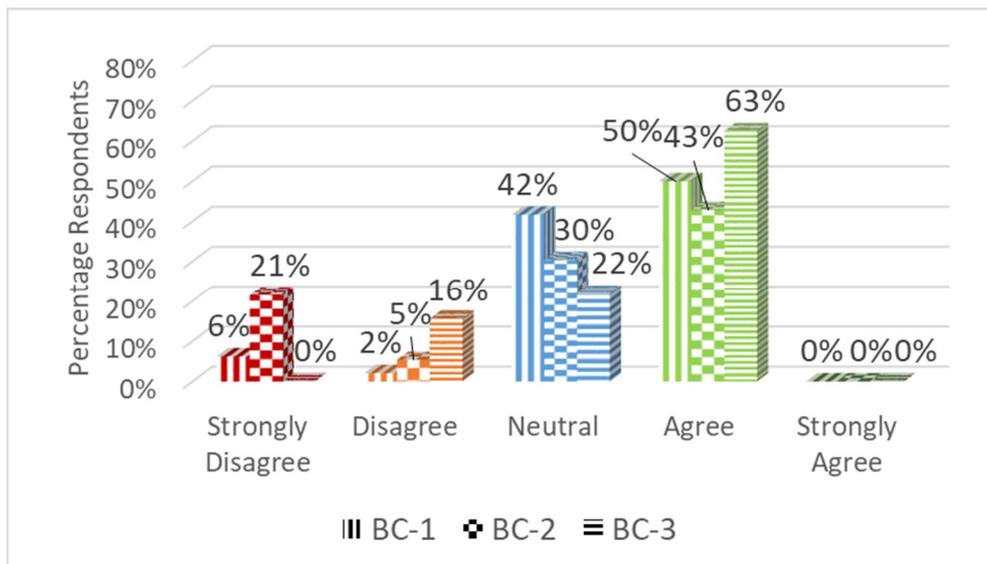


Figure 5.51: Cycles 1 to 3 respondents' perception of the fostering of *improvement of professional skills in the VCoP* (Trait 1, Sub-theme 1A).

The choice of most effective VCoP in fostering *improvement of professional skills in the VCoP* is not an open and shut case. Whereas Cycle 1 had a considerably lower combined agreement rate of 50% when compared to the 63% of Cycle 3, it also had a considerably lower combined disagreement rate (8% versus 16%). However, due to the much higher combined agreement rate, Cycle 3 was determined most effective. The rank order of cycle effectiveness regarding effectivity in fostering *improvement of professional skills in the VCoP*, is therefore 1st Cycle 3, 2nd Cycle 1 and 3rd Cycle 2 (Figure 5.52).

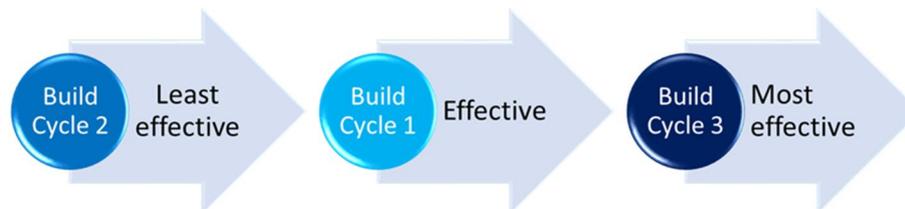


Figure 5.52: Comparison of the different cycles regarding effectiveness in fostering *improvement of professional skills in the VCoP*.

5.5.1.2 Acquiring new knowledge in the VCoP (Trait 1, Sub-theme 1B)

In Figure 5.53 the results show that, across all cycles, Cycle 3 respondents had the highest agreement perception (75%) on the sub-theme *acquiring new knowledge in the VCoP*. Cycle 3 also registered the second lowest combined disagreement response (13%) and had the lowest strongly disagree response rate at 0%. Cycle 2 not only showed the lowest agreement perception (43%) on *acquiring new knowledge in the VCoP*, but registered the

highest strongly disagree level at 24%. Cycle 2 therefore ranked least effective in terms of respondents' perception of the sub-theme *acquiring new knowledge in the VCoP*.

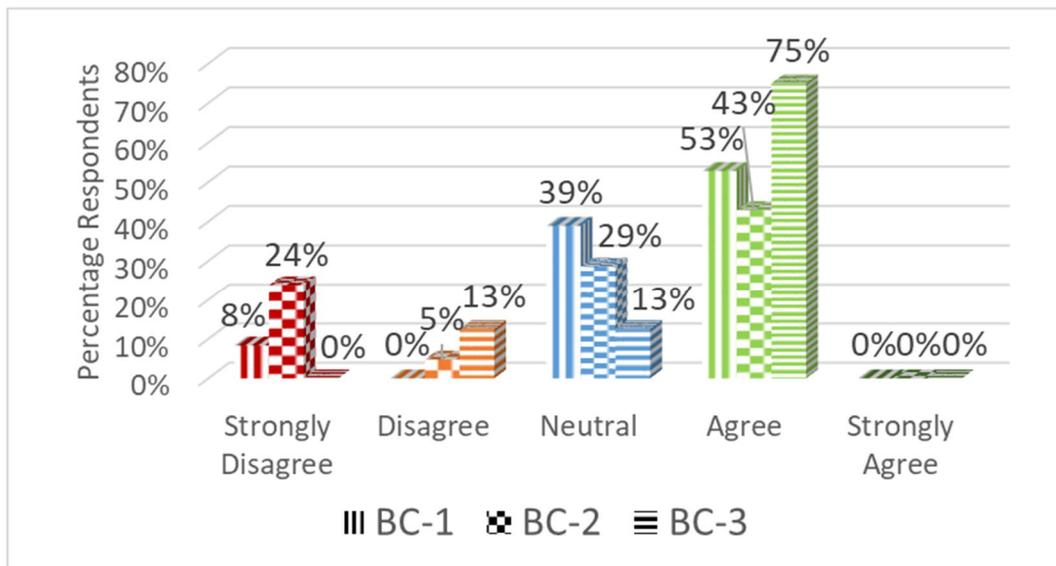


Figure 5.53: Cycles 1 to 3 respondents' perception of *acquiring new knowledge in the VCoP* (Trait 1, Sub-theme 1B).

The rank order of cycle effectiveness regarding fostering the sub-theme *acquiring new knowledge in the VCoP*, is therefore 1st Cycle 3, 2nd Cycle 1 and 3rd Cycle 2 (Figure 5.54).

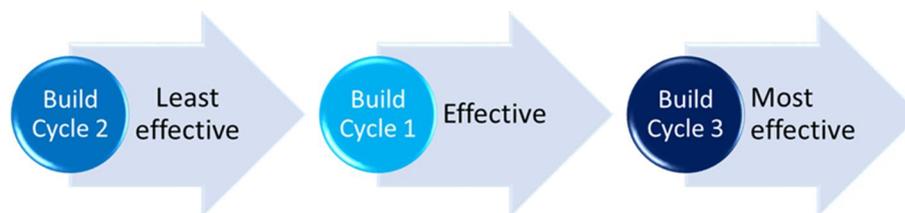


Figure 5.54: Comparison of the different cycles regarding effectiveness in fostering *acquiring new knowledge in the VCoP*.

5.5.1.3 Identifying with the profession in the VCoP (Trait 1, Sub-theme 1C)

The results in Figure 5.55 show that there was a strong agreement response of 54% in Cycle 1 on respondents' perception of the sub-theme *identifying with the profession in the VCoP*. Cycle 1 also registered the lowest combined disagreement level at 10% and the second lowest strongly disagree perception of 6% for this sub-theme. Despite Cycle 2 respondents showing the second highest combined agreement perception (50%) of *identifying with the profession in the VCoP*, it registered the highest combined disagreement response of 29% and the highest strongly disagree perception of 25%. This implies that respondents perceived Cycle 2 to be the least successful cycle in terms of the sub-theme *identifying with the profession in the VCoP*.

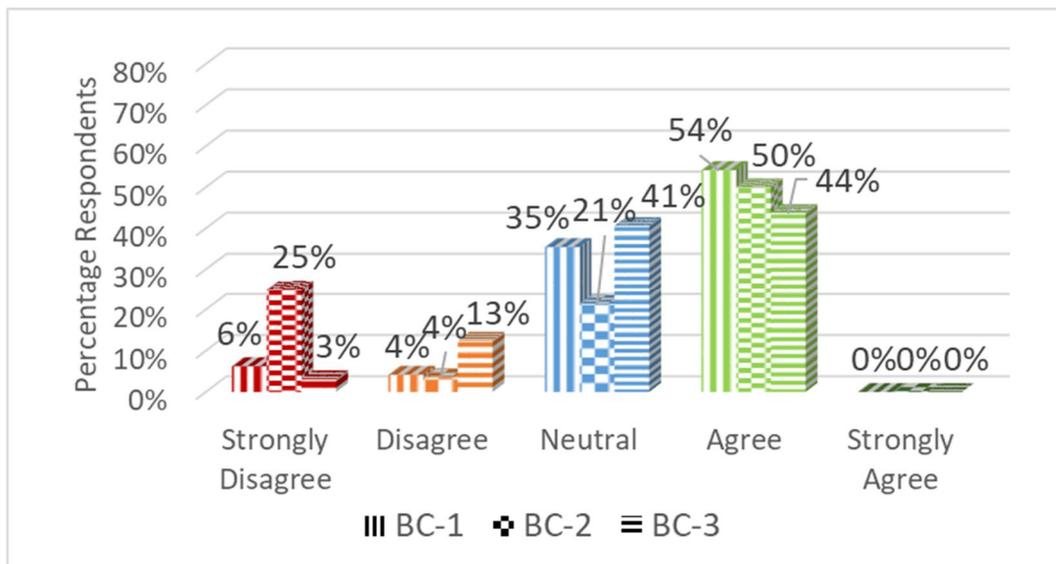


Figure 5.55: Cycles 1 to 3 respondents' perception of *identification with the profession in the VCoP* (Trait 1, Sub-theme 1C).

The rank order of cycle effectiveness regarding effectivity in fostering *identification with the profession in the VCoP*, is therefore 1st Cycle 1, 2nd Cycle 3 and 3rd Cycle 2 (Figure 5.56).



Figure 5.56: Comparison of the different cycles regarding effectiveness in fostering *identification with the profession in the VCoP*.

5.5.1.4 Learning through participation in the VCoP - summary of Trait 1 sub-theme effectiveness

Figure 5.57 shows a comparison of VCoP effectiveness in terms of the sub-themes in fostering *learning through participation in the VCoP*. Cycle 3, the highly structured VCoP that aligned with the pedagogical approach of lecture determination, was most effective in fostering *improvement of professional skills in the VCoP* (sub-theme 1A) and in fostering *acquisition of new knowledge in the VCoP* (sub-theme 1B). It was also the second most effective VCoP in terms of fostering *identification with the profession in the VCoP* (sub-theme 1C). This concurs with the Layer B retrospective comparison of traits, where it was determined that Cycle 3 was the most effective cycle in fostering *learning through participation in the VCoP* (Trait 1).

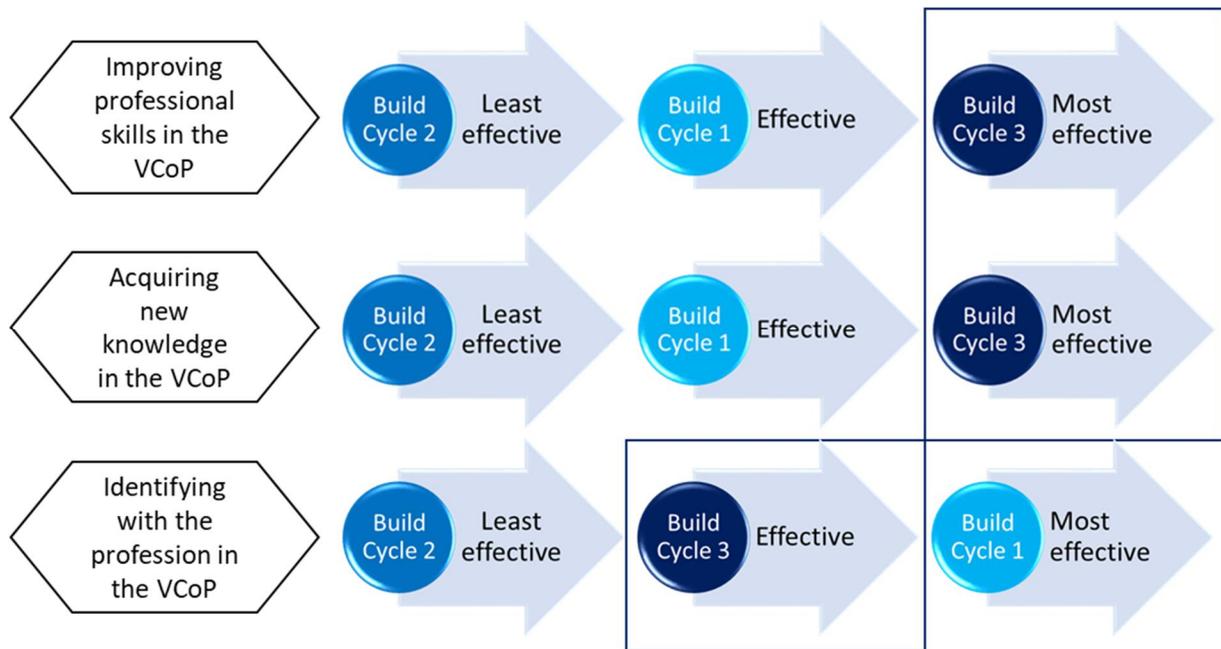


Figure 5.57: Comparison of the different cycles regarding effectivity in fostering all three sub-themes within the trait *learning through participation in the VCoP*.

5.5.1.5 Collective problem solving in the VCoP (Trait 2, Sub-theme 2A)

The results in Figure 5.58 show that there was a strong combined agreement response of 52% in Cycle 1 on respondents' perception of the sub-theme *collective problem solving in the VCoP*. Cycle 1 also registered the lowest combined disagreement level of 6%. Cycle 3 registered the lowest agreement perception of *collective problem solving in the VCoP* at 44% and the highest combined disagreement level of 13%. This made Cycle 3 the least effective cycle in terms of fostering *collective problem solving in the VCoP*.

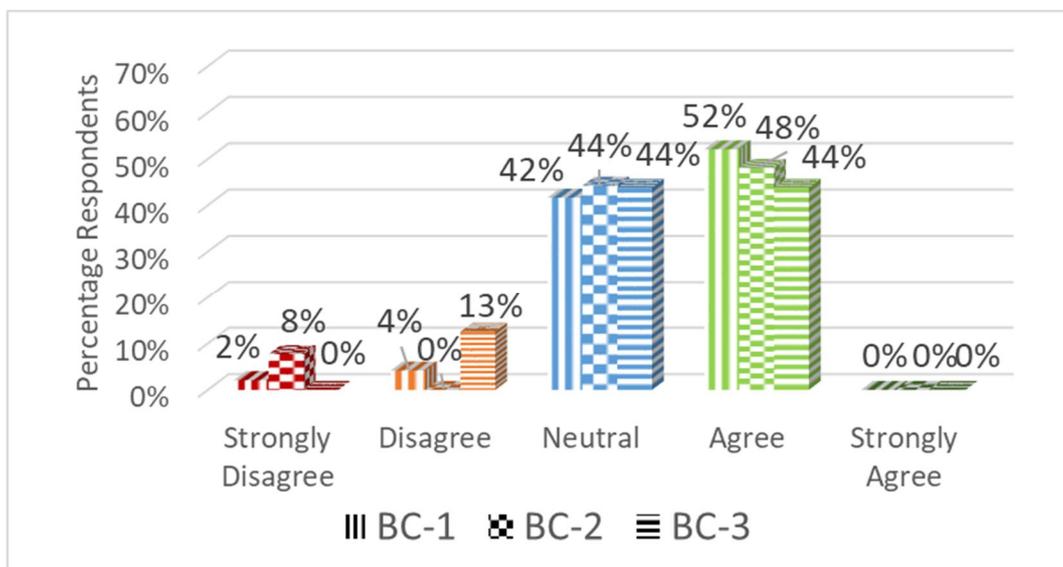


Figure 5.58: Cycles 1 - 3 respondents' perception of *collective problem solving in the VCoP* (Trait 2, Sub-theme 2A).

The rank order of cycle effectiveness regarding effectivity in fostering *collective problem solving in the VCoP* is therefore 1st Cycle 1, 2nd Cycle 2 and 3rd Cycle 3 (Figure 5.59).



Figure 5.59: Comparison of the different cycles regarding effectivity in fostering *collective problem solving in the VCoP*.

5.5.1.6 Debating domain-related issues in the VCoP (Trait 2, Sub-theme 2B)

In Figure 5.60 the results show that Cycle 1 respondents had a 44% combined agreement rate on the sub-theme *debating domain-related issues in the VCoP*. It also registered the second lowest combined disagreement level of 17%. However, Cycle 1 showed the highest strongly disagreement perception of 11%. Comparing Cycle 2 with Cycle 1, the results show that Cycle 2 participants registered a 3 percentage point lower combined agreement rate on the sub-theme *debating domain-related issues* (41%), a 1 percentage point lower combined disagreement level (16%) and a 3 percentage point lower strongly disagree perception. In making a call on the most effective cycle, the researcher used the combined non-negative responses. Cycle 2 was therefore regarded to be the most effective in fostering *debating domain-related issues*, as the combined non-negative response rate was 85% versus 83% for Cycle 1. Cycle 3 had the lowest agreement response (29%) and highest combined disagreement response (21%) of the three cycles, making it the least effective cycle in terms of fostering *debating of domain-related issues in the VCoP*.

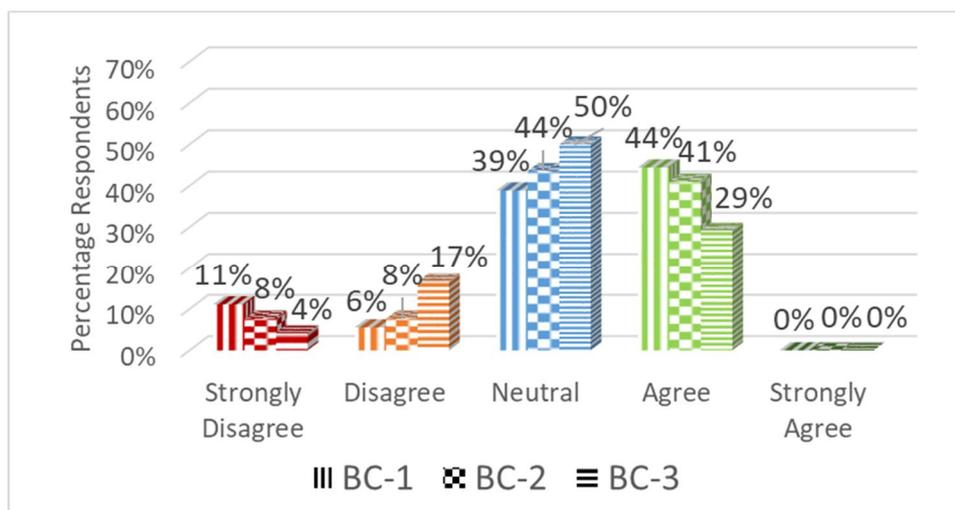


Figure 5.60: Cycles 1 - 3 respondents' perception of *debating domain-related issues in the VCoP* (Trait 2, Sub-theme 2B).

The rank order of cycle effectiveness regarding effectivity in fostering the *debating of domain-related issues in the VCoP* is therefore 1st Cycle 2, 2nd Cycle 1 and 3rd Cycle 3 (Figure 5.61).

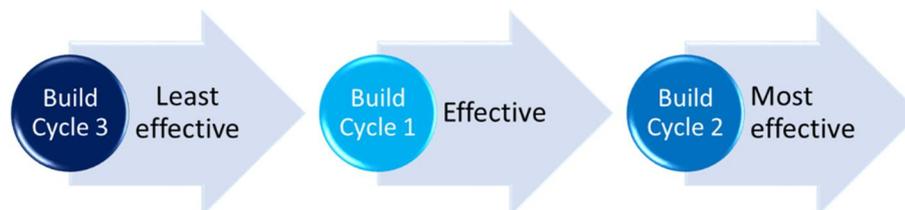


Figure 5.61: Comparison of the different cycles regarding effectivity in fostering the *debating of domain-related issues in the VCoP*.

5.5.1.7 Member interaction in the VCoP - summary of Trait 2 sub-theme effectiveness

Figure 5.62 shows a comparison of VCoP effectiveness of the sub-themes in fostering member interaction in the VCoP. No clear winner emerges between Cycles 1 and 2, with both cycles ranking first in one of the two sub-themes for Trait 2 and second in the other. The finding of the Layer B retrospective comparison of traits that Cycle 1 (the minimally structured VCoP that aligned with the heutagogical approach of self-determination) was the most effective cycle in terms of fostering *member interaction in the VCoP* (Trait 2) was therefore used to determine the overall most effective VCoP for this trait.

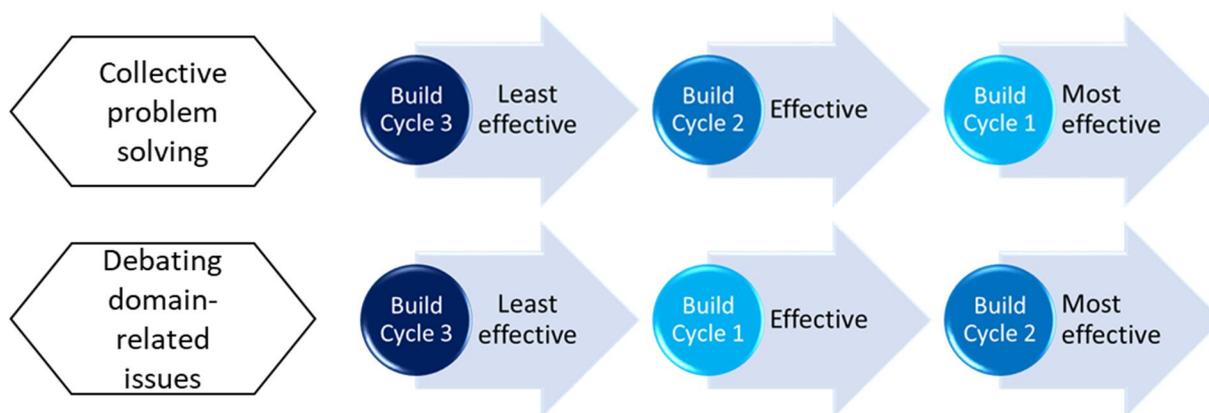


Figure 5.62: Comparison of the different cycles regarding effectivity in fostering both sub-themes within the *member interaction in the VCoP* trait.

5.5.1.8 Shared criteria in the VCoP (Trait 3, Sub-theme 3A)

The results in Figure 5.63 show that there was a 50% combined agreement response in Cycle 2 on respondents' perception of the sub-theme fostering *shared criteria in the VCoP*. However, for this sub-theme Cycle 2 registered the highest combined disagreement

response of 8% and the highest strongly disagree perception of 8%. Although Cycle 1 respondents showed only the second highest agreement perception of the *sharing of criteria in the VCoP* (45%) it registered the second lowest combined disagreement level of 4% and the second lowest strongly disagree level of 2%. When assessing the combined non-negative responses, Cycle 1 edges Cycle 2 by 95% to 92%. Cycle 1 was therefore regarded to be the most effective in fostering the sub-theme *shared criteria in the VCoP*.

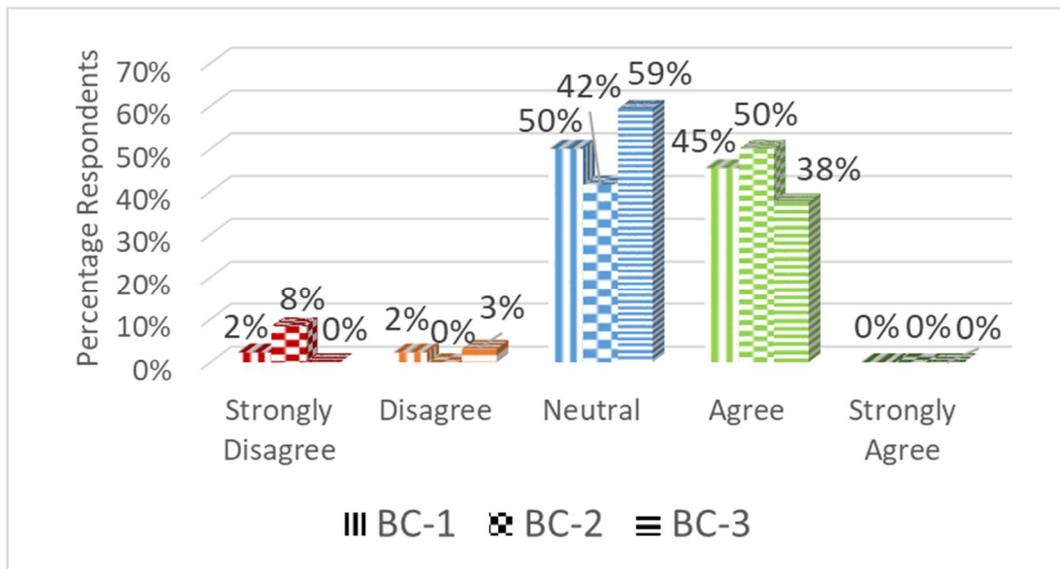


Figure 5.63: Cycles 1 - 3 respondents' perception of *shared criteria in the VCoP* (Trait 3, Sub-theme 3A).

The rank order of cycle effectiveness regarding effectivity in fostering *shared criteria in the VCoP* is therefore 1st Cycle 1, 2nd Cycle 2 and 3rd Cycle 3 (Figure 5.64).

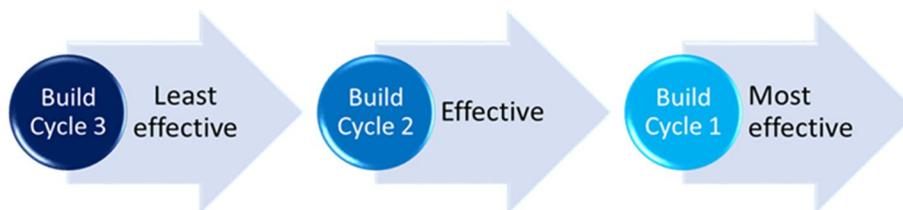


Figure 5.64: Comparison of the different cycles regarding effectivity in fostering *shared criteria in the VCoP*.

5.5.1.9 Shared practices in the VCoP (Trait 3, Sub-theme 3B)

In Figure 5.65 the results show that there was a strong 58% agreement for Cycle 2 on the sub-theme *shared practices in the VCoP*. Cycle 2 also registered the second lowest combined disagreement response of 11%. Cycle 1 respondents showed the second highest agreement level of 42%, as well as the lowest combined disagreement level of 3%. Due to the margin of difference in the combined agreement perception (58% for Cycle 2 versus

42% for Cycle 1), Cycle 2 was deemed most effective in fostering the sub-theme *shared practices in the VCoP*.

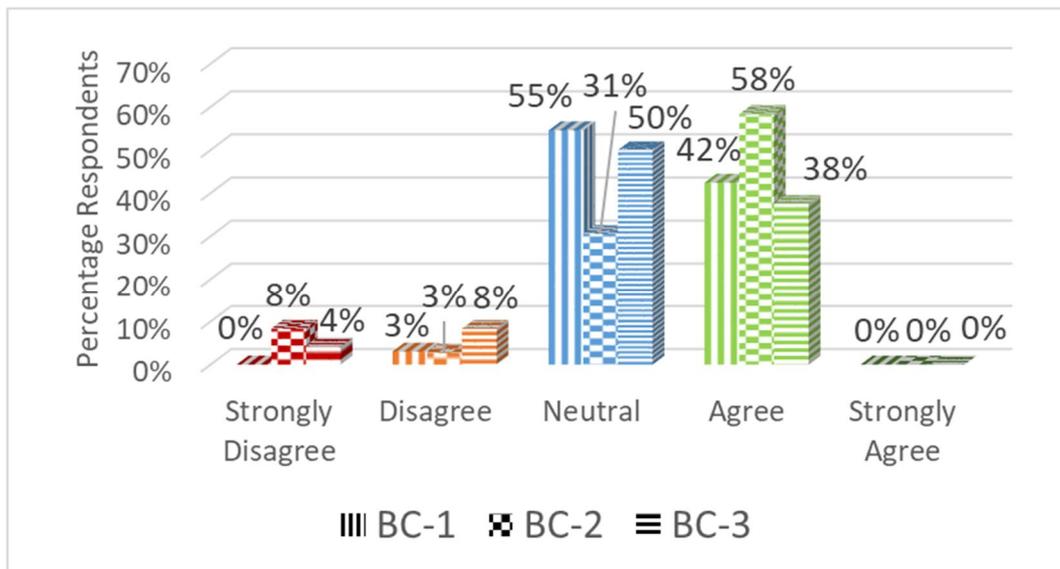


Figure 5.65: Cycles 1 - 3 respondents' perception of *shared practices in the VCoP* (Trait 3, Sub-theme 3B).

The rank order of cycle effectiveness regarding effectivity in fostering *shared practices in the VCoP*, is therefore 1st Cycle 2, 2nd Cycle 1 and 3rd Cycle 3 (Figure 5.66).

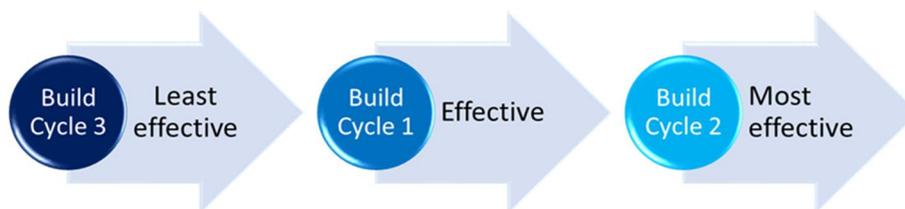


Figure 5.66: Comparison of the different cycles regarding effectivity in fostering *shared practices in the VCoP*.

5.5.1.10 The use of WhatsApp group specific tools and standards in the VCoP - summary of Trait 3 sub-theme effectiveness

Figure 5.67 shows a comparison of VCoP effectiveness of the sub-themes in fostering the *use of WhatsApp group specific tools and standards in the VCoP*. Cycle 1, the minimally structured VCoP that aligned with the heutagogical approach of self-determination, was most effective in supporting shared criteria (sub-theme 3A), whereas Cycle 2, the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, was most effective in supporting shared practices (sub-theme 3B). The findings of the Layer B retrospective comparison of traits showed that respondents perceived Cycle 2 to be the most effective cycle in terms of fostering the *use of WhatsApp group specific tools and*

standards in the VCoP. As no clear winner emerged from Layer C, the finding of Layer B was used in determining the most effective VCoP for Trait 3 (*use of WhatsApp group specific tools and standards in the VCoP*).

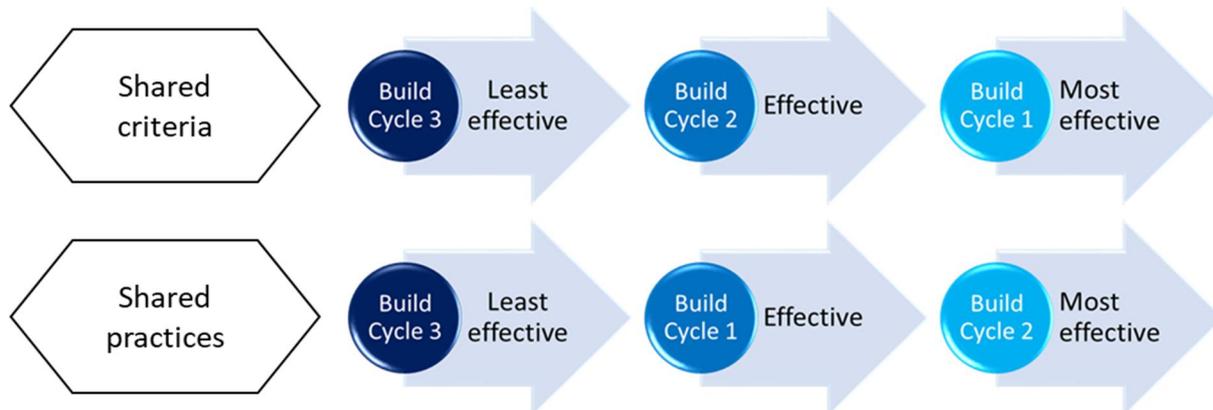


Figure 5.67: Comparison of the different cycles regarding effectivity in fostering both sub-themes within the *use of WhatsApp group specific tools and standards in the VCoP* trait.

5.5.1.11 Shared sense of professional community in the VCoP (Trait 4, Sub-theme 4A).

The results in Figure 5.68 show that there was a very strong agreement of 66% on the sub-theme about *shared sense of professional community in the VCoP* for Cycle 1. Cycle 1 also registered the lowest strong disagreement level of 2% and the second lowest combined disagreement level of 8%. Cycle 1 was therefore most effective in fostering the sub-theme *shared sense of professional community in the VCoP*. When comparing the respondents' perceived effectivity of this sub-theme in Cycles 2 and 3, Cycle 2 showed the second highest agreement perception of 57%. This was 12 percentage points higher than that of Cycle 3 (at 45%). Cycle 3 respondents showed the lowest combined disagreement perception (5%) of a *shared sense of professional community in the VCoP*. This was eight percentage points lower than that of the respondents in Cycle 2 at 13%. With Cycle 3 registering a strongly disagree perception of 5% (versus 10% for Cycle 2) and a combined non-negative response rate of 95% (versus 87% for Cycle 2), Cycle 3 is regarded as more effective than Cycle 2 in fostering a *shared sense of professional community in the VCoP*.

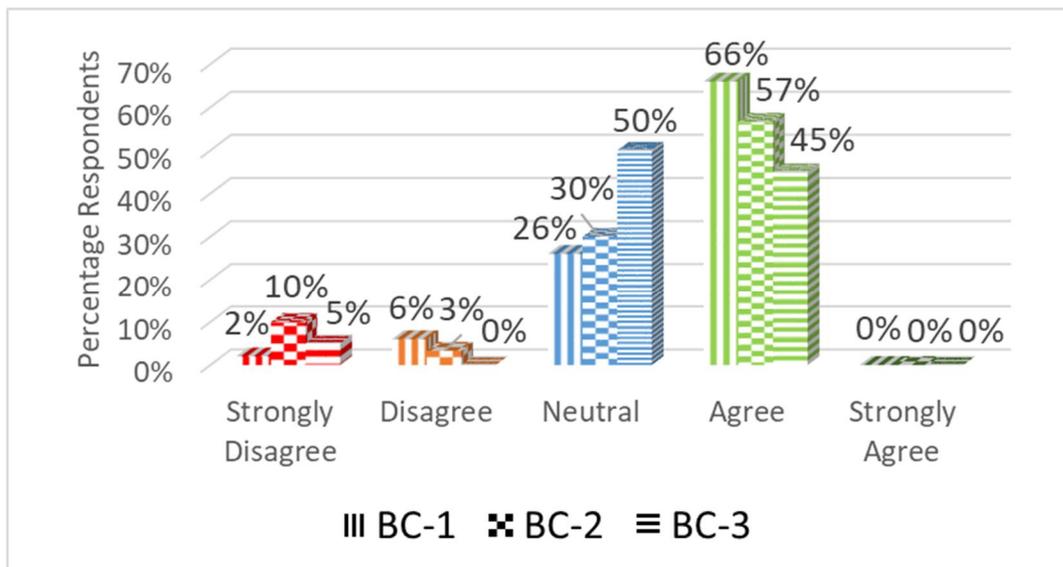


Figure 5.68: Cycles 1 - 3 respondents' perception of a *shared sense of professional community in the VCoP* (Trait 4, Sub-theme 4A).

The rank order of cycle effectiveness regarding effectivity in fostering a *shared sense of professional community in the VCoP*, is therefore 1st Cycle 1, 2nd Cycle 3 and 3rd Cycle 2 (Figure 5.69).



Figure 5.69: Comparison of the different cycles regarding effectivity in fostering a *shared sense of professional community in the VCoP*.

5.5.1.12 Members' knowledge of each other in the VCoP (Trait 4, Sub-theme 4B).

In Figure 5.70 the results show that there was a strong agreement rate of 52% for Cycle 2 on the sub-theme *members' knowledge of each other in the VCoP*. Respondents' combined agreement perception of *members' knowledge of each other in the VCoP* for Cycles 1 and 3 registered 36% and 38% respectively. As the magnitude of the combined disagreement perception for all 3 traits were similar, Cycle 2 emerged as the most effective in fostering the sub-theme *members' knowledge of each other in the VCoP*. In comparing Cycles 1 and 3, the following were taken into account: combined agreement (36% versus 38%), strong disagreement (14% versus 13%), combined disagreement (22% versus 23%) and combined non-negative responses (both 78%). Cycle 3 therefore narrowly edges out Cycle 1 for

second position in terms of effectiveness in fostering the sub-theme *members' knowledge of each other in the VCoP*.

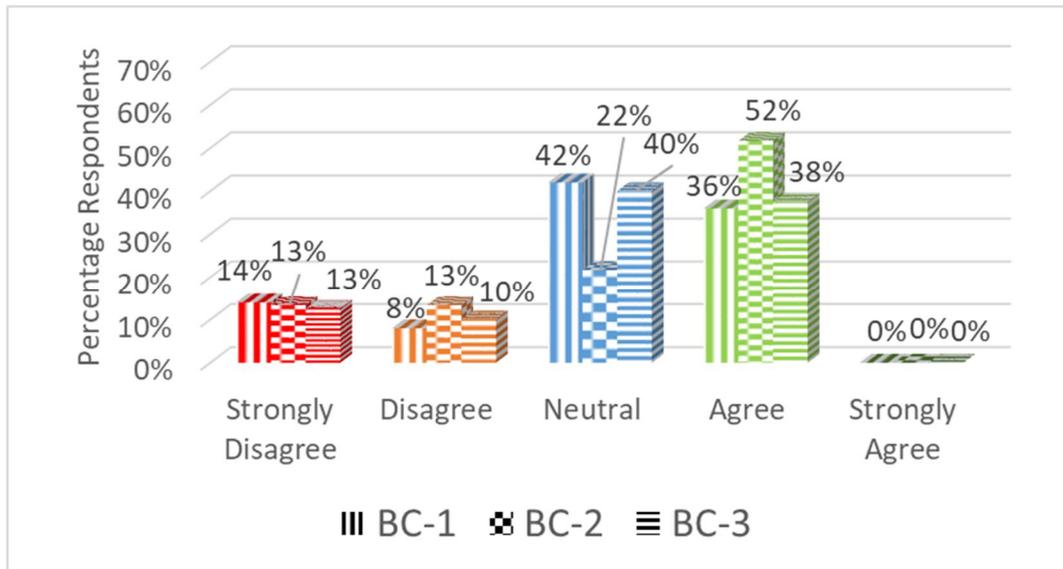


Figure 5.70: Cycles 1 - 3 respondents' perception of *members' knowledge of each other in the VCoP* (Trait 4, Sub-theme 4B).

The final rank order of cycle effectiveness is therefore 1st Cycle 2, 2nd Cycle 3 and 3rd Cycle 1 (Figure 5.71).



Figure 5.71: Comparison of the different cycles regarding effectivity in fostering *members' knowledge of each other in the VCoP*.

5.5.1.13 Sense of community in the VCoP - summary of Trait 4 sub-theme effectiveness

Figure 5.72 shows a comparison of VCoP effectiveness of the sub-themes in fostering a *sense of community in the VCoP*. The Layer C retrospective comparison of sub-themes showed that Cycle 1, the minimally structured VCoP that aligned with the heutagogical approach of self-determination, was most effective in supporting a *shared sense of professional community in the VCoP* (sub-theme 4A). Cycle 2, the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, was most effective in supporting *members' knowledge of each other in the VCoP* (sub-theme 4B). Using a scoring system of 3 points for ranking first, 2 points for second and 1 point for third, the three

cycles end in a tie regarding the sub-themes for a *sense of community in the VCoP* (Trait 4). The final decision on effectivity of the cycles to support a *sense of community in the VCoP* therefore rested with the findings of Layer B, the retrospective comparison of traits that found Cycle 2 to be the most effective cycle in terms of fostering a *sense of community in the VCoP*.

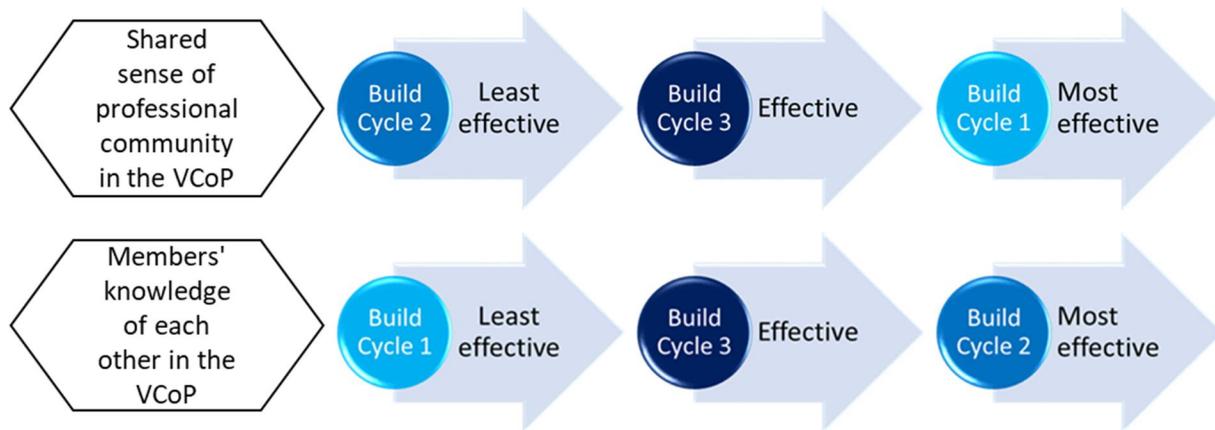


Figure 5.72: Comparison of the different cycles regarding effectivity in fostering both sub-themes within the *sense of community in the VCoP* trait.

5.5.1.14 Summary of retrospective comparison of sub-themes (Layer C)

Sub-research question 1 asked: Which essential traits of a virtual community of practice (VCoP) were fostered in each WhatsApp VCoP? During the formative evaluation, Layer A, this question was broadly answered in that all three cycles fostered all Wenger's (1998) essential traits of CoPs. To provide a more in-depth answer, a summative, retrospective comparison of essential traits across cycles, Layer B, was performed. This comparison showed that Cycle 2, the facilitated structured VCoP, was the most effective VCoP, as it ranked first in two of the four quantitatively analysed Wenger (1998) essential traits of CoPs. In Layer C, the summative, retrospective evaluation of each trait was further analysed at sub-theme level to gauge respondents' perceptions of VCoP effectiveness. Figure 5.73 shows a comparison of the different cycles' effectiveness in fostering the different sub-themes. Cycle 1, the minimally structured VCoP that aligned with the heutagogical approach of self-determination, was most effective in fostering four sub-themes: *identifying with the profession in the VCoP*, *collective problem solving in the VCoP*, *shared criteria in the VCoP* and *shared sense of professional community in the VCoP*. Cycle 1 also placed second in effectively fostering four sub-themes: *improving professional skills in the VCoP*, *acquiring new knowledge in the VCoP*, *debating domain-related issues in the VCoP* and *shared*

practices in the VCoP. Of the nine sub-themes, Cycle 1 only placed last in one sub-theme: *members' knowledge of each other in the VCoP*. Cycle 2, the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, was most conducive in fostering three sub-themes: *debating domain-related issues in the VCoP*, *shared practices in the VCoP* and *members' knowledge of each other in the VCoP*. Cycle 2 also placed second, after Cycle 1, in effectively fostering two sub-themes: *collective problem solving in the VCoP* and *shared criteria in the VCoP*. Of the nine sub-themes, Cycle 2 placed last in four sub-themes: *improving professional skills in the VCoP*, *acquiring new knowledge in the VCoP*, *identifying with the profession in the VCoP* and *shared sense of professional community in the VCoP*. Cycle 3, the highly structured VCoP that aligned with the pedagogical approach of lecture determination and in which researcher resource inputs were concept and time aligned with the TPL course, was most effective in fostering two sub-themes: *improving professional skills in the VCoP* and *acquiring new knowledge in the VCoP*. Cycle 3 placed second in three sub-themes: *identifying with the profession in the VCoP*, *shared sense of professional community in the VCoP* and *members' knowledge of each other in the VCoP*. In the next section the findings of this chapter are discussed.

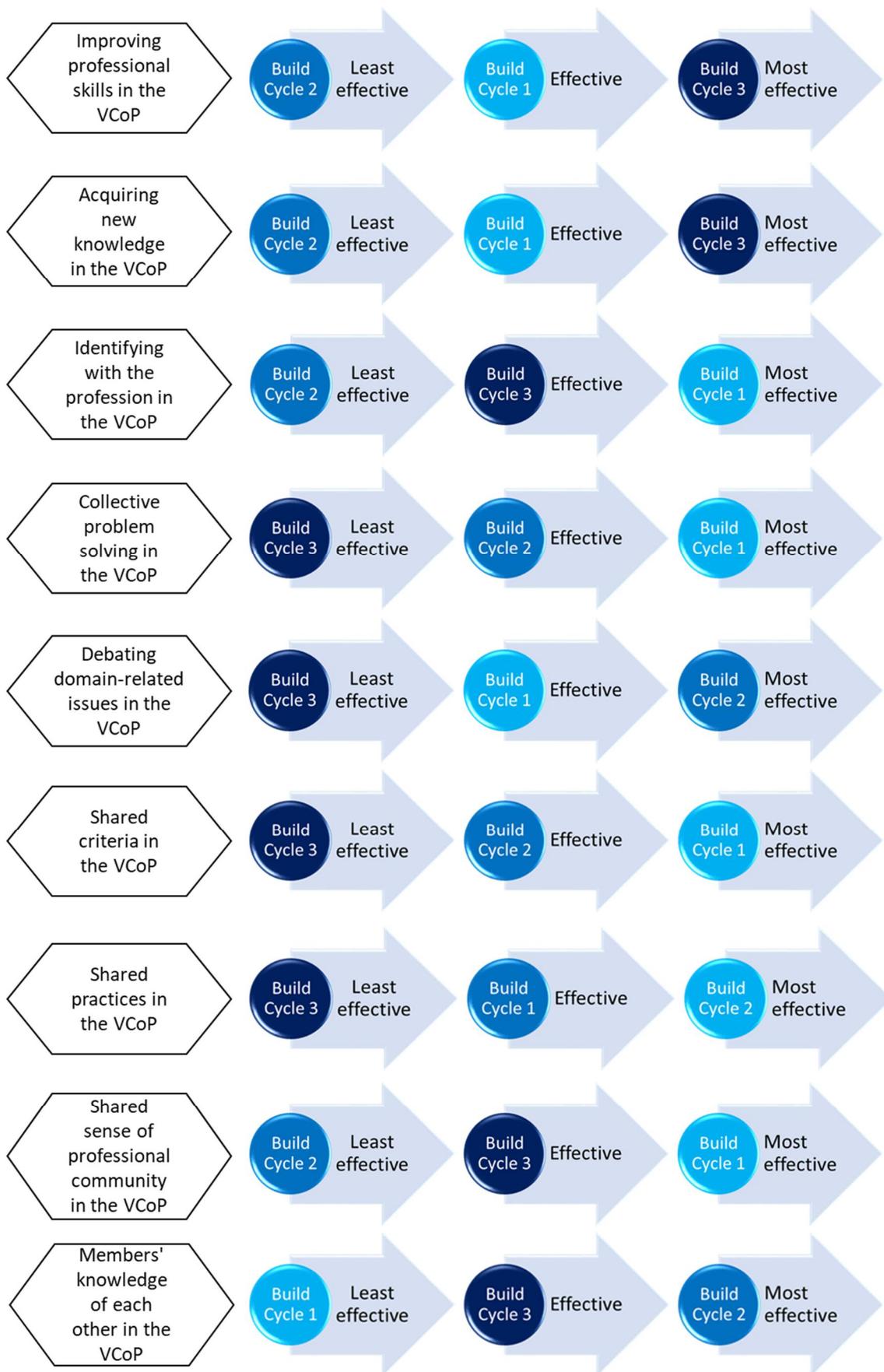


Figure 5.73: Final comparison of the different cycles regarding effectivity in fostering the nine Murrilo (2008) sub-themes.

5.6 Chapter discussion and conclusions

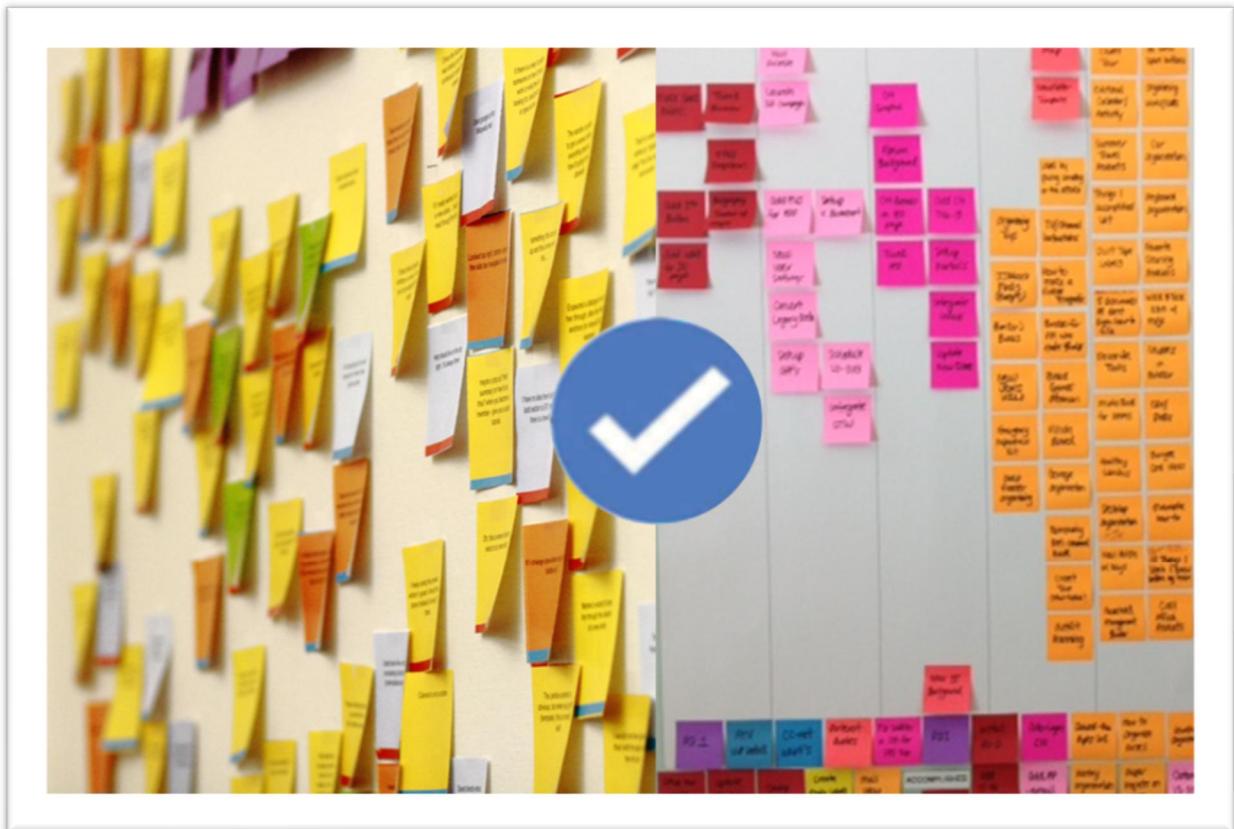
The main objectives for collecting and analysing data by means of the mainly quantitative VCoP validation questionnaire were (i) for the researcher to determine whether each WhatsApp group functioned as a VCoP and (ii) to provide the study with a way to formatively evaluate each iterative build cycle's VCoP to inform adaptations in subsequent cycles. In the formative evaluation of each cycle, Layer A, the findings show that all cycles formed successful VCoPs. The analysis of the data also informed sub-research question 1: Which essential traits of a virtual community of practice (VCoP) were fostered in each WhatsApp VCoP? In Layer B, a summative, retrospective evaluation of essential traits was carried out to rank the cycles according to their effectiveness in fostering Wenger's (1998) five essential traits of a CoP. This evaluation determined that, according to student perception, Cycle 2, the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, was most effective in fostering Wenger's (1998) five essential traits of a CoP. This concurs with Pittenger's (2013) finding that facilitated structured VCoPs best support learning through inter-professional collaboration. To gain a more in-depth understanding, a second summative, retrospective evaluation of the quantitative data was carried out. In this evaluation, Layer C, cycles were ranked according to their effectiveness in fostering Murillo's (2008) sub-themes in each essential trait. Where it was unclear which cycle performed best across the sub-themes within a trait, a simple scoring system was utilised, i.e. 3 points for ranking first, 2 points for ranking second and 1 point for ranking third. This same scoring system was used in the final analysis when comparing all the sub-themes to determine cycle effectiveness. Subsequently, Cycle 1, the minimally structured VCoP that aligned with the heutagogical approach of self-determination, was deemed most effective in fostering Murillo's (2008) sub-themes in each essential trait (Table 5.1).

Table 5.1:
The results of Layer C sub-theme ranking by means of the scoring system.

Sub-themes	Cycle 1	Cycle 2	Cycle 3
Improving professional skills in the VCoP	2	1	3
Acquiring new knowledge in the VCoP	2	1	3
Identifying with the profession in the VCoP	3	1	2
Collective problem solving in the VCoP	3	2	1
Debating domain-related issues in the VCoP	2	3	1
Shared criteria in the VCoP	3	2	1
Shared practices in the VCoP	2	3	1
Shared sense of professional community in the VCoP	3	1	2
Members' knowledge of each other in the VCoP	1	3	2
TOTAL	21	17	16

This finding concurs with Moore (1993; 2013) and Falloon (2011), who argue that increased dialogue, increased student autonomy and looser activity structure lead to the lowest transactional distance, and therefore higher course satisfaction. In the theoretical framework it was argued that learning in TPL short courses takes place at the intersection of the andragogic and heutagocic approaches. The two different outcomes in Layers B and C align with this argument, as the top ranking VCoP in Layer B followed an andragogical approach and the top ranking VCoP in Layer C a heutagocical approach. However, the essential trait sub-themes *improving professional skills in the VCoP* and *acquiring new knowledge in the VCoP* are central to the academic support envisioned for this study, as it links to level 2, participant learning, of Guskey's (2002) five levels of determining the effectiveness of professional development programmes. Participant learning refers to the knowledge and skills gained by participants. Thus, despite placing last on a purely quantitative and participant perceptual view of essential trait and sub-theme effectiveness, participants perceived Cycle 3 to support their learning most effectively. In other words, participants perceived the pedagogical approach most effective in supporting their learning.

In the next chapter, in answer to sub-research questions 2 to 6, the study's qualitative data is analysed using Ritchie and Spencer's (1994) thematic framework analysis process and Guskey's (2002) five levels of professional development effectiveness as analytical framework.



TEST: Part 2

- **Qualitative retrospective analysis of cycles to inform sub-research questions 2 to 6**

CHAPTER 6: PRESENTATION AND ANALYSIS OF RESULTS - VCoPs AS SUPPORT FOR PROFESSIONAL DEVELOPMENT PROGRAMME EFFECTIVENESS

Interpretation is a complex and dynamic craft, with as much creative artistry as technical exactitude, and it requires an abundance of patient plodding, fortitude, and discipline. There are many changing rhythms; multiple steps; moments of jubilation, revelation, and exasperation...
(Crabtree & Miller, 1999, p. 128)

6.1 Introduction

In this chapter the retrospective analysis and interpretation of the data, in answer to sub-research questions 2 to 6, are provided. These sub-research questions aimed to determine how the VCoPs in the different cycles supported professional development programme effectivity, as informed by Guskey's (2002) five levels of determining effectiveness. Design principles that emerged from the data are also presented. This chapter, together with Chapter 5, represents the 6th step in the Easterday et al.'s (2017) proposed seven-step iterative process for DBR - test the solution. Figure 6.1 provides a detailed outline of this chapter.

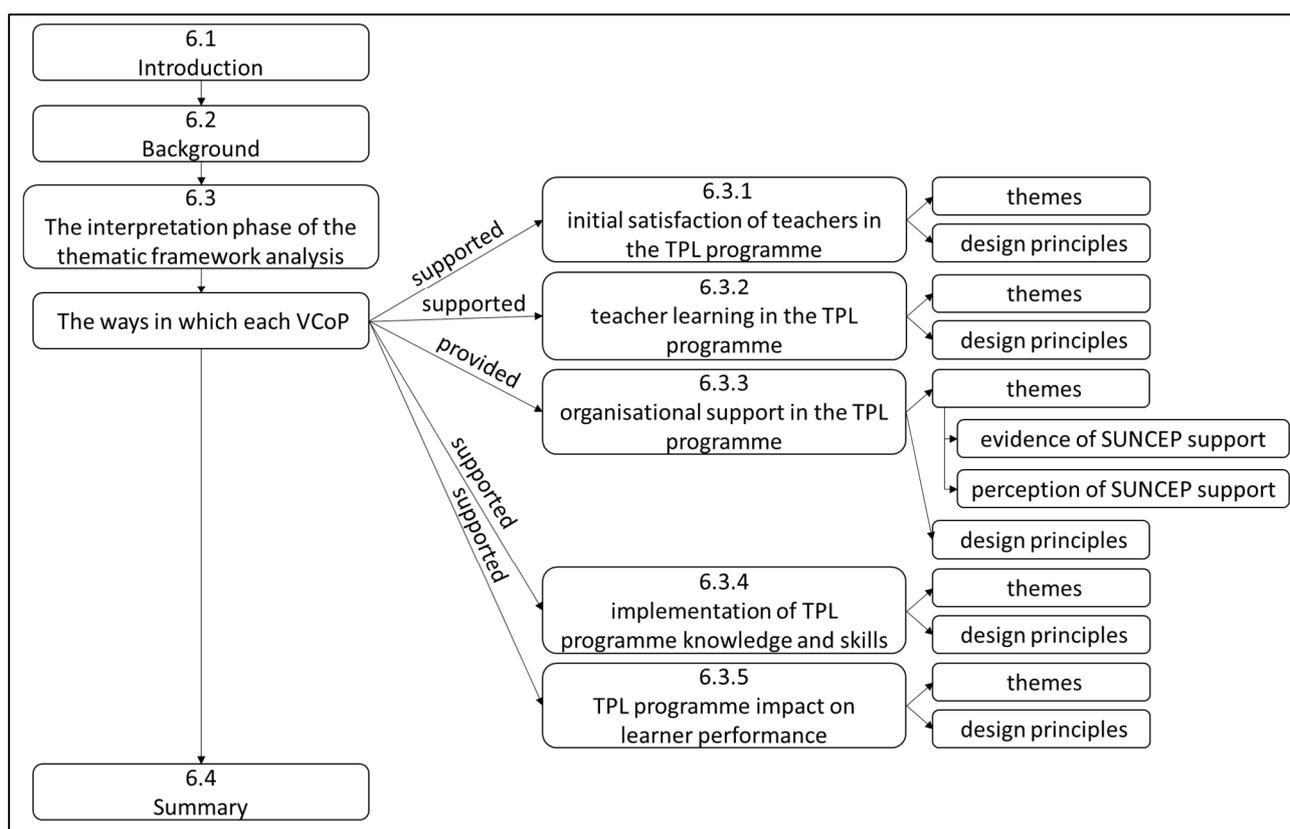


Figure 6.1: Chapter 6 outline.

6.2 Analysis within DBR research – a glance in the rear-view mirror

In DBR, two types of analyses of data are done. Firstly, formative evaluation after each cycle to refine the design and theory of the subsequent cycles. After completion of all the cycles a summative, retrospective analysis is carried out. A retrospective analysis allows the researcher the opportunity to "see order, pattern, and regularity in messy, complex settings" (DiSessa & Cobb, 2004, p. 84). Where the formative evaluation has a narrow view of each cycle, the retrospective analysis zooms out across all the cycles. According to Edelson (2002) retrospective analysis' overarching view supports the development of theory or at least, as Goff and Getenet (2017) propose for a doctoral thesis, design principles. These design principles should consider the conditions for success, as well as conditions that could lead to failure (Dede, 2014).

6.3 The interpretation phase of the thematic framework analysis

Data collected from the single qualitative question in the VCoP validation questionnaire, the transcribed interviews from the survey, as well as the narrative WhatsApp messages, were qualitatively analysed using thematic framework analysis (Ritchie & Spencer, 1994; Spencer et al., 2014) for retrospective evaluation of the study. In Chapter 4 (section 4.5.8.1) Ritchie and Spencer's (1994) first four stages of the five-stage thematic framework analysis were presented. These four stages are: familiarisation, identifying a framework, indexing, and charting and mapping. The interpretation phase is an intricately interwoven analytical process that is not only inseparable from the research questions, but also inseparable from all four other stages of framework analysis. Therefore, in this chapter, the presentation of the interpretation phase is divided into sections, mapped to each of sub-research questions 2 to 6. Each section is precluded with a brief summary of the main elements of the previous four phases.

6.3.1 The ways in which each VCoP supported the initial satisfaction of teachers in the TPL short courses

Sub-research question 2 asked in which ways each WhatsApp VCoP supported the initial satisfaction of teachers in the TPL short courses. The researcher therefore had to determine if participants perceived the VCoP to support TPL short course effectivity at the initial satisfaction level. Sub-research question 2 was informed by level 1 of Guskey's (2002) five levels of determining the effectiveness of professional development programmes: initial participant responses. Guskey (2002) defines initial responses as focussing on participants'

perceptions of effectivity, such as whether they liked the experience, whether their time was well spent, whether the material was meaningful and made sense, and whether the facilitators were knowledgeable. The following *a priori* codes were linked to this definition: #logistics (whether participants liked the experience and their time was well spent), #content choice (whether the material was meaningful and made sense) and #knowledgeability (whether the facilitators were knowledgeable). One data-driven code was added during the "identifying the analytical framework" stage of analysis, namely #language (whether participants were satisfied with the language chosen for messages to be posted in). South Africa has 11 official languages (Department of Justice and Constitutional Development, 1996). The languages of teaching and learning at Stellenbosch University (SU) are English and Afrikaans, with isiXhosa currently being targeted to develop as academic language (Stellenbosch University, 2016). These three languages correspond to the three official languages of the Western Cape Province (The Provincial Parliament of the Western Cape, 1998) in which SU resides. In accordance with the SU language policy, Cycle 1 and 2's VCoPs were conducted in English, as participants spoke various combinations of the 11 official languages. Cycle 3's VCoP was conducted only in Afrikaans, as that was the home and teaching language of all the participants. The participant response level was originally defined as a single category in the analysis framework. However, during the indexing stage the category participant response was divided into two sub-categories (referred to in section 6.3.1.1), namely (i) positive participant responses and (ii) negative participant responses. After indexing the WhatsApp group messages, the single qualitative survey question and the interviews with all four codes across the three cycles, different themes emerged from the mapping matrix.

6.3.1.1 Themes emerging from the VCoP participants' responses about initial satisfaction with the TPL short course

A total of twelve themes, across all cycles, emerged from the mapping matrix linked to whether participants perceived that the VCoPs supported the TPL short courses' effectiveness at the initial satisfaction level. Not all themes featured in each cycle, though. The different themes linked to the codes within each sub-category and will be discussed according to the codes they link to. To be able to compare effectiveness of the different cycles regarding participant response levels, both the positive and negative themes linked to each code are discussed, before moving on to the next code's themes. In some cases themes have the same name, as they refer to the same description, except that they differ

as to whether they refer to a positive or negative participant response. To avoid confusion for the reader the symbols (+) for positive and (-) for negative responses were added to the theme names.

For the code #logistics, five themes emerged. The first theme of *general satisfaction (+)* refers to participants demonstrating a general satisfaction with the use of the VCoP. This theme featured in all cycles as seen in examples of participant responses from the different cycles:

Interviews:

C1_Teacher 06⁴⁵: *Ja-nee, dit het beslis my behoeftes en belange ondersteun.* [Translation: Yes, it definitely supported my needs and interests]

C2_Teacher 01: *So...ja, in daai opsig dit...dit was lekker.* [Translation: So, yes, in that sense it was nice]⁴⁶

C3_Teacher 09: *Ja, dit was vinnig en doeltreffend* [Translation: Yes, it was fast and effective]

The second theme, *communication between students (+)*, refers to participants demonstrating their satisfaction with being able to synchronously communicate with each other on the VCoP. Although it is possible to communicate synchronously or asynchronously in WhatsApp, synchronous communication between members on a WhatsApp group is seen as a technological affordance of the application (Kirschner et al., 2004). One would therefore expect this theme to feature in all cycles. The theme *communication between students (+)* linked to the code #logistics and featured in all cycles, as represented by the following participant responses from the different cycles:

Interviews:

C1_Teacher 14: *En jy weet mense kan goedkoper...uhm...op 'n goedkoper manier met mekaar gesels, al is hul nie bymekaar nie.* [Translation: And you know people can speak to each other cheaply, even when they are not together]

C2_Teacher 12: *'n Mens bly in...uhm...hoe sal mens nou sê...uhh...nou sien...nou sien nou's die woorde missing...bly half in kontak met mekaar mens bly half in kontak met mekaar.* [Translation: One stays in, how would you say, now see, now the words are missing ... keep in contact with each other]

C3_Teacher 01: *Dit was beter, ja Researcher...want mens kon vinnig inligting kry en uitruil met mekaar.* [Translation: It was better, yes Researcher, because one could obtain information quickly and exchange it with one another]

⁴⁵ Participant names were anonymised. In Cycle 1 all participant pseudonyms start with C1, Cycle 2 with C2 and Cycle 3 with C3.

⁴⁶ Although the language of this WhatsApp group was English, teachers who were interviewed could choose to answer in Afrikaans.

C1_Teacher 14's response also gave insight into one of the reasons why the participants were prepared to use the VCoP, namely that WhatsApp messaging is a cheap communication tool. This concurs with McKane's (2018) finding that WhatsApp messaging is one of the cheapest ways of sending text messages in South Africa. C3_Teacher 01's response corresponds with Gachago, Strydom, Hanekom, Simons and Walters (2015) and Pimmer and Pachler's (2014) findings that social media platforms have the potential to act as boundary objects, by creating learning connections and facilitating increased immediacy between teachers who work and study in isolated areas. The response also shows that participants positively perceived WhatsApp's technological affordance of synchronous communication.

A third theme, *communication of logistics (+)*, refers to participants demonstrating their satisfaction with how logistics were communicated via the VCoP. In Cycle 1, the VCoP was created a week before the first contact session and students had to travel from all over the Western Cape Province to attend the contact sessions of the TPL course. Multiple examples of satisfaction with *communication of logistics (+)* were found, as represented by a VCoP message at the end of the first contact session:

C1_Teacher 10: *I think we must thank you again for all your support, quick responses and good communication!!!*

During the telematics sessions in Cycle 1, SUNCEP needed to take a roll-call of student attendance. The students quickly solved the problem by taking selfies with their cell phones and posting them on the WhatsApp group. This, together with multiple posts referring to the telematics set-up working correctly, venue access and students mentioning their arrival at the telematics venues, were deemed by the researcher as a demonstration of satisfaction with the *communication of logistics (+)* (Figure 6.2A). In Cycle 3 the students also used selfies as a roll-call method. Cycle 3 did not have a telematics broadcast, but students posted selfies during a web-streaming session (Figure 6.2B).

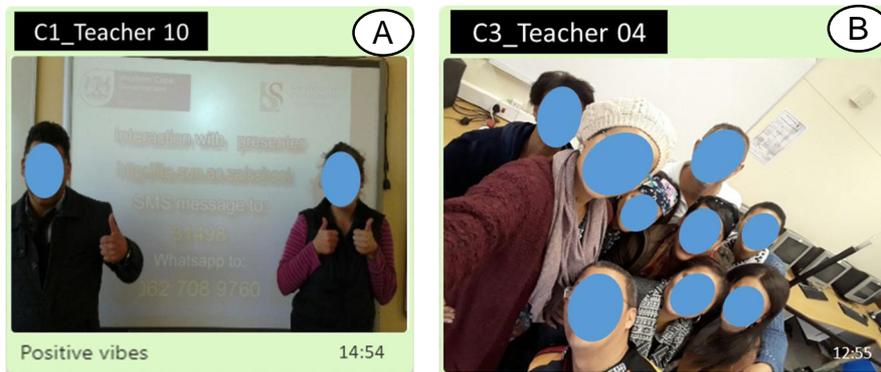


Figure 6.2: Participants showing satisfaction with attending broadcasting sessions [Theme: *communication of logistics (+)*].

In Cycle 2, no broadcasts formed part of the TPL short course and the VCoP was only created at the end of the last day of the contact session. One would therefore expect that little data linked to the *communication of logistics (+)* theme, and none were found. In Cycle 3 the VCoP was created a day before the first contact sessions. Students made all their logistical arrangements through their mentor (C3_Mentor), as she was also a facilitator on the TPL course. C3_Mentor was a SUNCEP staff member that stayed in the district where the TPL short course was presented. C3_mentor had been supporting teachers in the district on a separate private WhatsApp group for a number of years. As the private WhatsApp group did not form part of this study, no further data in Cycle 3, except for the data related to broadcasts in the cycle, linked to the *communication of logistics (+) theme*.

The fourth theme, *positive lurking (+)*, refers to participants demonstrating their satisfaction with being able to follow communications in the VCoP, without having to speak up themselves. This theme featured in Cycles 2 and 3, as represented by the following participant responses from the two cycles:

Interviews:

C2_Teacher 16: *Ek is mos nou maar 'n introvert. Ek het die inligting geles, hoor! Dit wat gesê was...uhm...dit lees ek, maar ek neem nou net nie deel aan...aan gesprekke byvoorbeeld of so nie.* [Translation: I am an introvert. I read the information, you know! That what was said, I read it, but I, for example, just don't take part in discussions.]

C3_Teacher 14: *Ek is maar 'n ou...ek hou daarvan om te lees, jy weet. En dan wat ek dan eerste gedoen het, ek gaan doen eers my tuiswerk voor ek gaan praat oor 'n ding.* [Translation: I am the sort of guy who likes to read, you know. And then what I did first was to do my homework before I started talking about anything.]

Positive lurking (+) aligns with Crawford (2009), who argues that lurkers in online communities, such as WhatsApp groups, are usually not inactive members, but they are often tracking the posts of others. The two quoted participants made it clear that, although

they did not necessarily post to the WhatsApp groups, they were active readers and followers on the groups. This finding supports Crawford's (2009) call to rather refer to lurkers than listeners. This finding also aligns with Lee, Chen and Jiang (2006) and Rimé (2017) who argue that, in any social context, on- or offline, the supposed inactive participation of listeners do not detract from the overall functioning of that community.

One purely negative theme emerged from both the interviews and the survey question. *Off-topic conversation* (-) refers to participants demonstrating dissatisfaction with the number of off-topic conversations in a VCoP. In Cycle 1, where students were allowed to post social content on weekends, there were participants expressing their dissatisfaction in WhatsApp messages and during the interviews.

Interview:

C1_Teacher 46: *Ja, my enigste probleem met die WhatsApp was, mense wat begin om te sê geluk vir die een en dan sê 20 ander geluk of mense wat sê...uhm...dit voel vir my dit is nie die platform van wat dit gedoen moet word nie. Ek dink daar moet uhm...uhm...boundaries...perke gestel word aan wat word op die WhatsApp groep bespreek.* [Translation: Yes, my only problem with the WhatsApp was people that would start to congratulate someone and then 20 or more would add their congratulations. I feel that this is not the correct platform think that boundaries should be set as to what can be discussed on the WhatsApp group]

WhatsApp message:

C1_Teacher 32: Omw⁴⁷ don't u guys work??? Forever chatting tje⁴⁸! My data 😞

The researcher picked up on this theme during Cycle 1 and, consequently, participants in Cycles 2 and 3 were discouraged from any social conversations in the VCoPs. Therefore, this theme did not feature in Cycle 2 at all. However, in Cycle 3, despite very few posts of a social nature, one participant still expressed his/her dissatisfaction with off-topic conversations in the survey:

C3_Teacher B: *Ja en Nee. Onnodige gesprekke word gevoer wat nie van toepassing is.* [Translation: Yes and No. Unnecessary conversations that are not appropriate, take place.]

On the whole though, participants' responses to logistics were positive across all three cycles.

⁴⁷ Omw is an abbreviation for "Oh my word".

⁴⁸ "Tje" is a tongue click made by South Africans to show a negative emotion.

For the code #content choice, three themes emerged from the mapping matrix. The first theme, *general content (+)*, refers to participants demonstrating their general satisfaction with the course content posted in the VCoP, as represented by the following participant responses:

Interviews:

C1_Teacher 14: *Ek was regtig waar...uhm...diep beïndruk jy weet, met die materiaal.*
[Translation: You know, I was really very impressed with the material.]

C2_Teacher 16: *Ja-Nee, dit was van pas ja.* [Translation: Yes-No⁴⁹, it was appropriate.]

C3_Teacher 13: *Verseker! Ja-Nee, definitief.* [Translation: For sure! Yes- No, definitely]

The second theme, *curriculum content (+)*, refers to participants demonstrating their satisfaction that the course content posted in the VCoP aligned to the curriculum, as represented by the following participant responses:

Interviews:

C1_Teacher 06: *Die kursus was baie ryk aan inhoud ...uhm...praktiese aktiwiteite ...dit het regtigwaar dit wat voorgeskryf was in die KABV dit het dit regtigwaar gesteun.*
[Translation: the course was rich in content and practical activities. It genuinely supported what is prescribed in the CAPS, it really supported it.]

C2_Teacher 02: *I remember there was a question you asked about the polar bodies...ah ja, I think one of the participants...about the polar bodies within...uhm...the process of meiosis...uhm... during formation of the ovum. You know, and there was so much discussion and people were asking questions and I also participated in this one and read it, you know what happens to the polar bodies...the polar bodies, you know...and you shared so much information.*

C3_Teacher 09: *Ja, ek dink dit was baie toepaslik, veral die video materiaal en goeters.*
[Translation: Yes, I think it was really appropriate, especially the video material and stuff]

The third theme, *curriculum content (-)*, was found in Cycle 2, where participants were dissatisfied with content that went outside of the scope of the exam guideline:

WhatsApp message:

C2_Teacher 22: *The people are confusing us. Just teach what the exam guideline says. Isn't it policy?*

Both the researcher and the Northern Cape Education Department subject advisor (C2_NCED) informed this participant that teachers should always have a broader subject knowledge than that which is captured in either an exam guideline or the curriculum. This

⁴⁹In South Africa the combined Yes-No means: "An emphatic affirmation of what one has said or is about to say, or of what someone else has said." (*Dictionary of South African English*, 2018)

is necessary in order for teachers to be able to assist 21st century learners, who might use other textbooks or the internet as information source. The participant responded positively to the feedback given:

WhatsApp message:
C2_Teacher 22: *True that.*

The themes *general content (+)*, *curriculum content (+)* and *curriculum content (-)* speak to the notion of TSPCK as necessary component to develop the Nature of Science (NOS) in TPL short courses (Rollnick & Davidowitz, 2015). The themes also align to this study's design outcome 3, which aimed to support participants in the VCoPs with practice-based content that supported and enhanced TPL students' course needs (Chapter 4, Section 4.5.1.5). Overall, the participants' responses to content choice posted in the VCoPs were positive across all three cycles.

For the code #knowledgeability, two positive themes emerged from the mapping matrix. The first theme, *general knowledgeability (+)*, refers to participants demonstrating their satisfaction with facilitator knowledgeability and helpfulness in the VCoP. In Cycle 1, C1_Teacher 16, in an interview, commented on how the facilitators were knowledgeable and helpful, both during contact sessions and in the VCoP:

C1_Teacher 16: *Die manier hoe julle...uhm...te werk gegaan het om vir ons...oor te dra wat nodig was, was vir my puik gewees. En julle het dit net verder extend op die...op die WhatsApp groep. [Translation: The way you worked to convey the necessary to us, was great. And you really extended it further on the WhatsApp group.]*

Participants in Cycle 1 also reacted positively when facilitators posted news items, linked to the curriculum, on the WhatsApp group, as represented by the following participant response:

C1_Teacher 07: *Thanks for the info! You are truly team awesome!!!!*

This type of response was also mapped to the theme of *general knowledgeability (+)*. An example of a response linked to *general knowledgeability (+)* in Cycle 2 was:

Interview:
C2_Teacher 01: *Ek moet sê ek het baie gehou van daai vragies en goed wat jy aan die begin gesit het. [Translation: I must say I liked the questions and stuff you placed at the beginning a lot]*

In Cycle 3, no data from either the VCoP or the interviews mapped to *general knowledgeability (+)*, but in the qualitative question from the VCoP validation survey participants demonstrated their satisfaction with facilitator helpfulness in the VCoP:

C3_Teacher A⁵⁰: *...and within seconds facilitators responded to our texts. What a privilege it has been, and still is, to have been a part of this group.*

The second theme linked to participants demonstrating their satisfaction with the facilitators' methods and practice of teaching adult learners. As this refers to andragogy, the theme was labelled *andragogic knowledgeability (+)*. This theme was found in Cycles 1 and 3, as represented by the following participant responses:

Interview:

C1_Teacher 14: *Die manier hoe dinge oorgedra was, jy weet, op 'n toepaslike wyse en...en...jy weet dis natuurlik grootmense... volwassenes wat op 'n ander manier leer...en...definitief...dit was op ons vlak gewees.* [Translation: You know, the way things were conveyed in an appropriate way and, you know, these are adults that learn in a different way. It was definitely at our level]

C3_Teacher 01: *Van julle kant af het julle ook vir my dit goed gedoen, die manier ...die manier die inligting oorgedra het...baie aanvaarbaar gemaak en verstaanbaar dus...vir my.* [Translation: From your side too, you definitely did it well for me too. The way the information was conveyed was very appropriate.]

As Appova and Arbaugh (2017) included andragogy as one of their proposed four pillars that motivates an adult to learn, finding this theme within the data was seen as a positive development. Cycle 1 and 3 participants perceived their VCoPs as effective to support adult learning. On the whole, the participants' responses to facilitator knowledgeability were deemed positive across all three cycles. This finding also speaks to the study achieving to present in each VCoP both the design and direct facets of teaching presence, as described by Anderson, Rourke and Garrison (2001).

For the code #language, one positive and one negative theme emerged from the mapping matrix. The positive theme of *Inclusive language use (+)* refers to participants demonstrating satisfaction with language use in the VCoPs. This theme was only found in Cycle 1, as it was the only cycle where participants taught in various languages. In Cycle 2 all participants taught in English, although their home languages did differ. In Cycle 3 all participants taught in Afrikaans and their home language was Afrikaans. It was therefore expected that the code #language and its concurrent themes would only be found in Cycle 1. In Cycle 1 participants voiced their satisfaction with the researcher proposing that the group's language of communication should be English, e.g.:

⁵⁰ As the surveys were completed anonymously, the researcher could not link an answer to a specific participant, but only to the cycle. Therefore the participants were labelled alphabetically and not numerically, e.g. C3_Teacher A.

WhatsApp message:

C1_Teacher 08: *Excellent. I like your comment*

Another example of inclusive language use occurred later when an issue arose with a few participants posting messages in Afrikaans. In response, the isiXhosa home language speakers posted messages in isiXhosa. An Afrikaans group member defused the language issue after the researcher posted a request for all to revert to English. This was also deemed an example of *inclusive language use (+)*.

WhatsApp message:

C1_Teacher 46: *Ndithetha kancinci kodwa andicomplain!!* [Translation: I only speak it a little bit, but I am not complaining.]

C1_Teacher 03: *Thanks you make us feel safe and welcome*

From that point forward, participants would translate each other's posts when someone, in haste, posted in Afrikaans. C1_Teacher 13 commented on this during the interview:

C1_Teacher 13: *As ek nou vat ek het miskien iets in Afrikaans gesê, en ander wat nou...uhm...Engelssprekend was...dan kon iemand anders weer gehelp het om byvoorbeeld te translate* [Translation: If I perhaps said something in Afrikaans, then someone else could, for example, help to translate.]

The negative theme *exclusive language use (-)* linked to one participant who did not agree that English should be the only language of communication in the Cycle 1 VCoP:

WhatsApp message:

Cycle 1: C1_Teacher 17: *Ok kwi⁵¹...sorry i am out...*

This theme also linked to the incident previously mentioned, where participants posted in Afrikaans, and isiXhosa home language speakers responded in isiXhosa. These postings were also labelled as *exclusive language use (-)*:

WhatsApp message:

C1_Teacher 08: *Kawuthethe isiXhosa mkhaya nathi asiyazi i Afrikaans* [Translation: Let's speak isiXhosa with each other, because we don't understand Afrikaans]

On different occasions, participants also reminded other participants to remain with English:

WhatsApp message:

C1_Teacher 03: *English is medium of communication, for good morals let us keep that. I really want to be able to read the WhatsApps.*

⁵¹ "kwi" is shortened, slang version, of "OK well"

Although it was most participants' second language, participants in Cycle 1 were in general satisfied with the use of English as the language of communication.

In Table 6.1 a summary of the themes that linked to the initial response of participants to TPL short course effectiveness can be found. The table indicates in which cycles the various codes and themes featured.

Table 6.1:

A summary of themes that mapped to the initial response of participants to TPL short course effectiveness, ordered by codes.

Code	Theme	Cycle 1	Cycle 2	Cycle 3
#logistics	General satisfaction (+)	✓	✓	✓
	Communication between students (+)	✓	✓	✓
	Communication of logistics (+)	✓		✓
	Positive lurking (+)		✓	✓
	Off-topic conversation (-)	✓		✓
#content choice	General content (+)	✓	✓	✓
	Curriculum content (+)	✓	✓	✓
	Curriculum content (-)		✓	
#knowledgeability	General knowledgeability (+)	✓	✓	✓
	Andragogic knowledgeability (+)	✓		✓
#language	Inclusive language use (+)	✓		
	Exclusive language use (-)	✓		

6.3.1.2 Design principles that support initial response to TPL short course effectiveness

In answer to sub-research question 2, the researcher was able to identify several ways in which each VCoP supported the initial satisfaction of teachers in the TPL short courses, by taking into account the different themes that emerged from the data. All VCoP cycles supported participants' general initial satisfaction. All three VCoPs also created opportunities for participants to communicate with one another in cases where they were physically far apart. In Cycle 1, participants mentioned the WhatsApp platform as a cheap communication tool, confirming the suitability of WhatsApp as VCoP platform for all three cycles. Therefore, the structure of all three VCoPs generally supported initial satisfaction and participant communication.

The study suggests that, for a VCoP to be useful as a platform to communicate logistics with participants, it should be created well ahead of the first contact session, as was the case in

Cycle 1. This finding forms Design principle 1. The participants should also not be part of separate VCoPs with course facilitators, as was the unfortunate case in Cycle 3. Design principle 2 is to discourage off-topic conversations in the VCoP. This was deduced from the negative perception of off-topic conversations by several participants in Cycle 1. In Cycles 2 and 3, implementation of Design principle 2 probably led to fewer participants actively posting in the VCoPs. The interviews with the perceived inactive participants in Cycles 2 and 3, however, showed that they were lurking positively and were therefore still actively learning within the VCoPs. All three cycles' VCoPs reported overall satisfaction with the general and curriculum-related content posted by the researcher and facilitators. The study's third design outcome, a VCoP with practice-based content that supports and enhances TPL students' course needs, was deemed met by the researcher during the planning stages. The participants' overall perception of satisfaction concurs with the researcher's conclusion regarding design outcome 3. Design principle 3 is therefore to ensure that most content posted is curriculum-related. This can include content that is linked to, and expands on, the curriculum statement. Only positive themes relating to facilitator knowledgeability emerged from the data in all three cycles. All of the Cycle 1 and 3 VCoP participants were of the perception that facilitators on their WhatsApp groups were effective in supporting adult learning. Cycles 1 and 3's VCoPs could therefore support adult learning effectively. In Cycle 2, no positive or negative responses to this theme were found, which made it impossible to make deductions regarding participants' perception of facilitators' *andragogic knowledge*. Design principle 4 is to ensure that facilitators who join the VCoPs have experience in supporting adult learning. Issues around the language in which the VCoP operated also emerged from Cycle 1. Cycle 1 had the only VCoP where participants taught in various languages. English, the second language of most of the participants, was chosen as common VCoP language. Problems arose when participants posted messages in their home languages, instead of in English. Design principle 5 is therefore to clearly communicate the VCoP's common language to participants when creating the VCoP, and for facilitators on the group to be extremely vigilant in picking up on, and quickly responding to, postings in a different language. A summary of the five design principles, linking to sub-research question 2, that emerged from the framework analysis can be found in Table 6.2.

Table 6.2:

A summary of the five design principles of VCoPs that support initial satisfaction of TPL short course effectiveness (sub-research question 2), emerging from the thematic framework analysis.

Design principle #	Description of design principle
1	<ul style="list-style-type: none"> The VCoP should be created well ahead of the first contact session <ul style="list-style-type: none"> to be useful as a platform that communicates logistics Participants should also not be part of separate VCoPs with course facilitators.
2	<ul style="list-style-type: none"> Off-topic conversations in the VCoP should be discouraged.
3	<ul style="list-style-type: none"> Ensure that most of the content posted is curriculum-related.
4	<ul style="list-style-type: none"> The service provider of the TPL short course should ensure that facilitators in the VCoP have experience in supporting adult learners.
5	<ul style="list-style-type: none"> To avoid issues around language: <ul style="list-style-type: none"> clearly communicate the VCoP's common language to participants when creating the VCoP facilitators in the VCoP must be extremely vigilant in noticing, and responding to, postings in languages other than the common language.

6.3.2 The ways in which each WhatsApp VCoP supported teacher learning in the TPL short courses

Sub-research question 3 asked in which ways each WhatsApp VCoP supported teacher learning in the TPL short courses. The researcher therefore needed to determine if there were demonstrations of student learning present in the VCoPs. The sub-category Participant Learning TPL focussed on demonstrations of learning that linked to messages posted during the TPL contact, telematics or streaming sessions. Sub-category Participant Learning WhatsApp focussed on demonstrations of learnings that linked to questions or activities posted by participants or the researcher in the VCoP. Only the WhatsApp group messages were analysed, as the survey question and interviews could only provide participant perception, and not measurable demonstrations, of student learning. Sub-research question 3 is informed by level 2 of Guskey's (2002) five levels of determining the effectiveness of professional development programmes: participant learning. Guskey (2002) defines participant learning as the measuring of "the knowledge and skills that participants gained" (p.46). Two *a priori* codes link to this definition: #knowledge (demonstrations of participant topical knowledge learning) and #skills (demonstrations of participant skills learning). No data-driven codes emerged during the "identifying the analytical framework" stage of analysis. The participant learning category was divided into

two sub-categories (i) TPL participant learning and ii) WhatsApp participant learning. TPL participant learning refers to demonstrations of participant learning in the VCoP, during TPL contact or broadcasting sessions. WhatsApp participant learning refers to demonstrations of participant learnings that linked to questions or activities posted by participants, or the researcher, in the VCoP. After indexing the WhatsApp group messages with both these codes across the three cycles, different themes emerged from the mapping matrix.

6.3.2.1 Themes emerging from the TPL and WhatsApp teacher learning sub-categories

Three main themes, collated from eight initial themes, emerged from the mapping matrix and linked to how each WhatsApp group VCoP supported TPL short course effectiveness at the teacher learning level. Not all main themes or initial themes featured in each cycle though. Only positive learning events were coded, as no negative events presented themselves. Before presenting the four main themes, the different initial themes, linking to the codes within each sub-category, will be discussed.

For the code #knowledge six initial themes emerged. The first initial theme, *inclusive learning*, refers to a VCoP allowing all participants to share their answers on the WhatsApp group, either in TPL contact or broadcasting sessions, or in answer to researcher posted material on the group. This initial theme featured in all cycles. In Cycle 1 this initial theme only featured in the TPL participant learning sub-category. An example comes from the first contact session where the facilitator verbally asked the course participants to post higher-order questions on the topic of global warming, in the VCoP:

C1_Teacher 04: *Why is it a problem if the earth's average temperature gets a little warmer?*

C1_Teacher 30: *What effect will global warming have on our ecosystems?*

C1_Teacher 03: *Explain the effects of the greenhouse gases in the living organism.*

Twenty-one participants answered the facilitator's question. In the traditional contact session class setup, a facilitator would only have had time to ask two or three students to share their answers with the class. The VCoP therefore created a more inclusive learning environment for participants. Cycle 1 participants only asked questions regarding assignments or logistics outside of contact sessions. They did not use the VCoP to discuss content or share best practices from their classrooms. The perception by 53% of participants in the VCoP validation questionnaire that they acquired new knowledge in the VCoP

(Chapter 5 section 5.5.1.2) therefore mainly links to what transpired on the group during TPL contact sessions.

In Cycle 2 the VCoP only started after the TPL contact session and there were no broadcasting sessions. Inclusive learning events were therefore only possible in the WhatsApp participant learning sub-category. An example of *inclusive learning* was participants answering a quiz question, posted by the researcher in the VCoP:

C2_Teacher 02: 0%

C2_Teacher 20: *Normal man × Normal female. Therefore 100% will be normal. So the answer is 0%*

C2_Teacher 21: 0%

Eight participants answered the quiz question on the group. This kind of answering can possibly lead to participants just repeating the first person's answer. However, the participants in Cycle 2, in most instances, had varying answers.

Although *inclusive learning* was theoretically possible in the TPL participant learning sub-category in Cycle 3, no facilitators used the group to that effect. Inclusive learning events were only found in the WhatsApp participant learning sub-category. An example of *inclusive learning* was participants answering a multiple choice quiz question, posted by the researcher in the VCoP:

C3_Teacher 13: C

Researcher: *Dankie Teacher C3_13. Ek gaan geen antwoord gee voor almal nie probeer het nie. [Translation: Thank you C3_Teacher 13. I will not be giving the answer before everyone has made an attempt.]*

C3_Teacher 09: C

C3_Teacher 04: C

Eleven participants answered the quiz question on the group. In this case, all the answers were identical, but the question had not been a difficult one. The *inclusive learning* initial theme concurs with Rambe and Bere (2013) and Susilo (2014) who find that the use of WhatsApp can enhance inclusive learning.

The second initial theme mapping to the code #knowledge, *inclusive formative assessment*, refers to a VCoP allowing facilitators a fast, reflective view into participants' learning. According to the Oxford Dictionary of English (Stevenson, 2010, p.884) inclusivity is defined

as "the practice or policy of including people who might otherwise be excluded or marginalized". In Cycle 1, this initial theme only featured in the TPL participant learning sub-category. An example comes from the telematics streaming session where the facilitator verbally asked the course participants whether solid fossil fuels were still forming on Earth. Twenty-five participants answered on the WhatsApp group. Below are examples of two of the answers:

C1_Teacher 22: *"No, we just said that we now have bacteria that will decompose plants before they can form coal"*

C1_Teacher 01: *"Yes. Natural process."*

The facilitator could formatively assess whether participants understood the concept being discussed. In the quoted posts, C1_Teacher 22's answer was correct and C1_Teacher 01's answer was incorrect. This gave the facilitator the opportunity to address misconceptions within the telematics session.

An example of *inclusive formative assessment* was found in Cycle 2 when participants answered a quiz question, posted by the researcher in the VCoP:

C2_Teacher 20: *Orange*

Researcher: *Thanks for being the first C2_Teacher 20, I am not going to say who is right or wrong until at least 10 people have attempted an answer. 😊*

C2_Teacher 25: *Purple and Orange*

C2_Teacher 04: *Purple*

After posting the question, the researcher could, within the following 3 hours, determine whether the participants understood both the quiz and the concept being assessed.

The initial theme *inclusive formative assessment* was found in Cycle 3 when the researcher attempted to create a safe space for participants to answer more intricate questions. This involved questions being posted as video clips in the VCoP, but participants could click on the researcher's name in the group and send their answers via a private message. Feedback to the participants was also given privately, with the best answer being posted back to the group. An example of such an answer can be found in C3_Teacher 09's answer to a question about the balancing of a chemical equation (Figure 6.3).

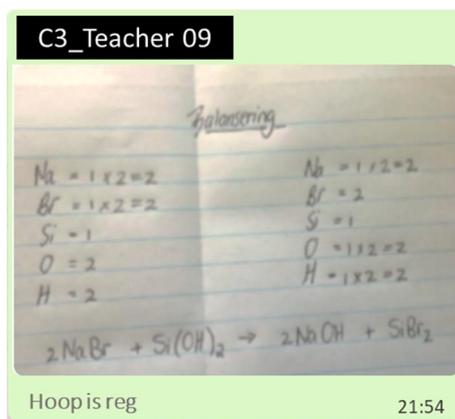


Figure 6.3: C3_Teacher 09's answer⁵² as example of the VCoP allowing for *inclusive formative assessment*.

Lin (2018) and Wen and Tsai (2006) argue that digital anonymity during assessment can prevent the adverse influence of social effects, such as perceived peer pressure or fear of failure. Teachers who had not previously answered questions on the group, were found to answer questions only when they could post their answers anonymously to the researcher (off-group). By providing students the option to be assessed anonymously from the other members of the group, a process was created that included students who had been excluded in cases where answers had to be posted on the group. In Cycle 3, exactly this kind of inclusivity, as defined by Stevenson (2010), was found. This allowed the researcher the opportunity to formatively assess the conceptual knowledge of a wider set of participants than what was the case during the other cycles.

In some instances the passages coded for *inclusive formative assessment* not only gave the researcher insights into students' learning, but it also led to problem-solving discussions in the VCoP. A third initial theme, *interactive problem-solving*, therefore emerged. This initial theme refers to a VCoP allowing students to interact and to discuss and debate content-related problems. As mentioned previously, in Cycle 1, the minimally structured VCoP that aligned with the heutagogical approach of self-determination, participants did not use the VCoP to discuss content. Therefore, the initial theme *interactive problem solving* did not feature in this VCoP. In Cycle 2, the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, participants participated in problem-solving discussions in response to researcher input. *Interactive problem solving* could only feature

⁵² Translation of message: "Hope it is correct"

in the WhatsApp participant learning sub-category, as the VCoP was only created at the end of the contact session. An example of this theme was found in the responses of the students, NCED_2, and the researcher to a vignette (Chapter 5, Figure 5.16) posted by the researcher:

C2_Teacher 21:	<i>The motor neuron is damaged so he felt the pain but impulses were not sent to the effector(muscles) for the muscles to contract and be able to pull the hand away from the stove.</i>
C2_Teacher 01:	<i>I agree with C2_Teacher 21. Because it is unknowingly it tells us that he did not feel the pain so sensory nerve is damaged.</i>
C2_Teacher 04:	<i>He was able to place his hand on hot stove so motor function is fine.</i>
C2_Teacher 01:	<i>👍</i>
C2_Teacher 19:	<i>His motor neuron is damaged as the impulse was not sent to the effector to respond fast to prevent further damage.</i>
C2_Teacher 02:	<i>The interneuron didn't send the impulse from the sensory neurons to the motor neurons. Or the sensory neurons didn't detect the stimuli from the hot plate.</i>
Researcher:	<i>Many interesting ideas. 😊. It is sometimes good to have questions where you have to think out of the box. I agree that motor neuron function probably normal as she could put her hand on plate and as she was working in the kitchen her normal responses probably was not impaired. Her reflex arc was however impaired in some way - like you mentioned. 😊</i>
C2_Teacher 26:	<i>Her sensory neuron could detect and relay the impulse perfectly! The motor neuron is probably damaged that is why no response could be effected.</i>
C2_Teacher 21:	<i>What's the correct response mam?</i>
C2_Teacher 26:	<i>Nowhere it is stated that she could not feel pain, but it is mentioned that she did not pull her hand away! So, I still believe that the pain stimulus was picked up, but there was no response.</i>
C2_Teacher 01:	<i>The question states that he/she unknowingly placed. I interpret unknowingly that you do not know that it is happening. So would love to see the memo on that question. And the Afrikaans wording to the question.</i>
C2_NCED:	<i>I think if he could feel the pain, he would have moved his hand with his other hand? So he was not aware of the heat - thus sensory neuron. Just an idea 😊.</i>

In Cycle 3, a highly structured VCoP in which researcher resource input was concept and time aligned with the TPL course, participants responded with their answers or suggestions to questions or vignettes (pedagogical approach of lecture determination). Despite answering, no real academic discussions took place on this group, and subsequently no instances of the theme *interactive problem solving* were found.

Barron (2000) contends that it is an educational imperative that facilitators create opportunities for their students to engage in collaborative problem-solving. Cycle 2 was the only VCoP that succeeded in effectively creating opportunities for collaborative problem-solving.

The fourth initial theme mapping to the code #knowledge, *interactive broadcasting*, refers to a VCoP allowing the one-way broadcast of telematics or streaming sessions to become interactive, reciprocal learning experiences. This initial theme only applied to Cycles 1 and 3, as Cycle 2 did not have any broadcasts. As broadcasting sessions are defined as contact sessions, this initial theme only featured in the TPL participant learning sub-category. One example from Cycle 1 was already shown within the theme *inclusive formative assessment*. If the VCoP had not allowed participants to give feedback to the facilitator presenting the telematics broadcast, formative assessment would not have been possible. In Cycle 3, during the streaming broadcast, participants did a hands-on activity, building balanced equations with jelly sweets. They could share their answers with the facilitator by taking photos with their cell phones and posting it in the VCoP (Figure 6.4):

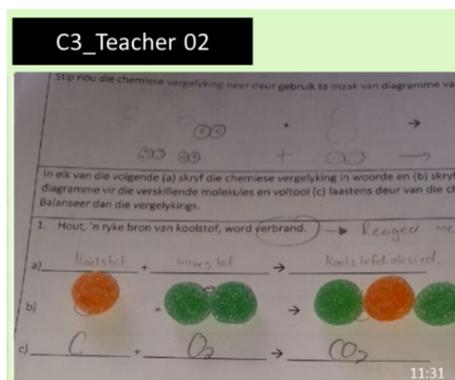


Figure 6.4: Screenshot of C3_Teacher 02's answer during a streaming session, as an example of the initial theme *interactive broadcasting*.

The initial theme *interactive broadcasting* directly links to one of the rationales for SUNCEP initiating the use of WhatsApp groups during broadcasts. SUNCEP students had expressed the need for dialogical teaching and learning, whereas telematics broadcasts were perceived as predominantly monological (Ndlovu & Hanekom, 2014). This need was echoed by nursing students attending telematics broadcasts during a Stellenbosch University postgraduate nursing education programme (Essa, 2010).

The fifth initial theme mapped to the code #knowledge, *content learnings repository*, refers to the VCoP allowing participants and facilitators to share participant content learnings with

the class, and for all to be able to refer back to it after contact sessions. The *content learnings repository* initial theme therefore only featured in the TPL participant learning sub-category. This initial theme could only feature during Cycles 1 and 3, as the Cycle 2 WhatsApp group only started at the end of the contact session. In Cycle 1, participants posted photos of posters they created in class (Figure 6.5A) and in Cycle 3 participants posted photos of hands-on activities (Figure 6.5B):

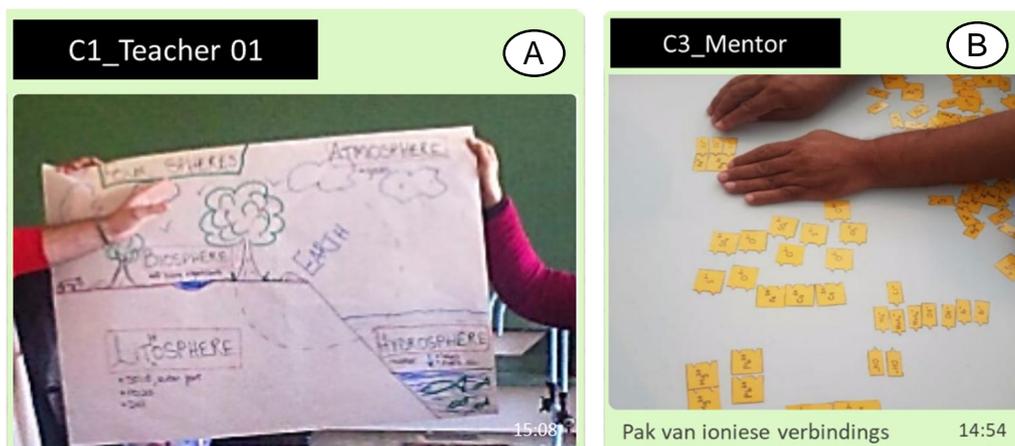


Figure 6.5: Screenshots of participant postings as examples of the theme *content learnings repository* in Cycle 1 (A) and Cycle 2 (B).

VCoPs are often used as learning repositories, for example the 343 000 member Sermo (<http://www.sermo.com/>) VCoP, which mainly serves physicians from the United States and the United Kingdom. The Sermo VCoP members share clinical reports (learnings) and use the VCoP to assist in collaborative paper writing (Lara et al., 2017).

The sixth and final initial theme mapped to the code #knowledge, *summative assessment repository*, refers to the VCoP allowing facilitators the opportunity to capture enactment tasks, to assess learning after the contact session. This initial theme only featured in Cycle 1 when, during the third contact session, participants had to present role plays to their peers. It therefore only featured in the TPL participant learning sub-category. The topic of the role-play was indigenous star stories. The researcher recorded video clips of each of the enactments using the WhatsApp group video recording function. After all groups presented their role-plays, participants could re-look at all the enactments and peer-assess each other. After the contact session, the researcher could also go back to the recordings and summatively assess each group's performance. The use of video clips to record an enactment for assessment has been intrinsically part of the sports sciences for decades (Mohsen & Thompson, 1997; Zecha, Einfalt, Eggert, & Lienhart, 2018). Bannink (2009) and Wiens, Hessberf, LoCasale-Crouch and DeCoster (2013) report that video clips of

enactments can also be valuable and valid components of teacher education digital portfolios. A VCoP that acts as a summative assessment repository, by supporting video recording for assessment of enactments, aligns with this trend in assessment.

For the code #skills two initial themes emerged. The first initial theme, *methods learning repository*, refers to a VCoP allowing participants to share hands-on teaching ideas that they encountered within the contact sessions. The *methods learning repository* initial theme therefore only featured in the TPL participant learning sub-category. This initial theme was only possible within Cycles 1 and 3, as the Cycle 2 VCoP only started after the contact session. In Cycle 1, an example of *methods learning repository* was found in the posting of C1_Teacher 01 that showed the participants using cards marked A, B, C or D in a formative assessment activity (Figure 6.6A). In Cycle 3, C3_Mentor posted photos of the different practices she encountered during the class visits she undertook to support participants (Figure 6.6B)



Figure 6.6: Screenshots of examples of the *methods learning repository* initial theme in Cycle 1 (A) and Cycle 3⁵³ (B).

One of Wenger's (1998) essential traits of CoPs is the sharing of practices, with the aim that participants will learn new teaching methods from each other. Both the VCoPs in Cycles 1 and 2 acted as methods learning repositories, with students demonstrating and sharing skills that they learned during the course.

The second initial theme, linked to the code #skills, is *laboratory skills learning repository*. It refers to a VCoP allowing participants and facilitators to share, with the class, participant

⁵³ School name has been blocked out for anonymity. Translation: Grade 7 learner from School X

laboratory skills learnings. This initial theme was only found within Cycles 1 and 3. Part of the reason for this could be that the Cycle 2 VCoP only started after the contact session, which meant that participants could not share skills learnt during the contact sessions. Cycle 2 students did not share laboratory skills or practices from their own classrooms either. In Cycle 1, an example of *laboratory skills learning repository* was found in the posting of C1_Teacher 04, which showed the safe set-up of a rock cycle simulating experiment (Figure 6.7A). In Cycle 3, C3_Teacher 12 posted a photo of the use of a separation funnel (Figure 6.7B).

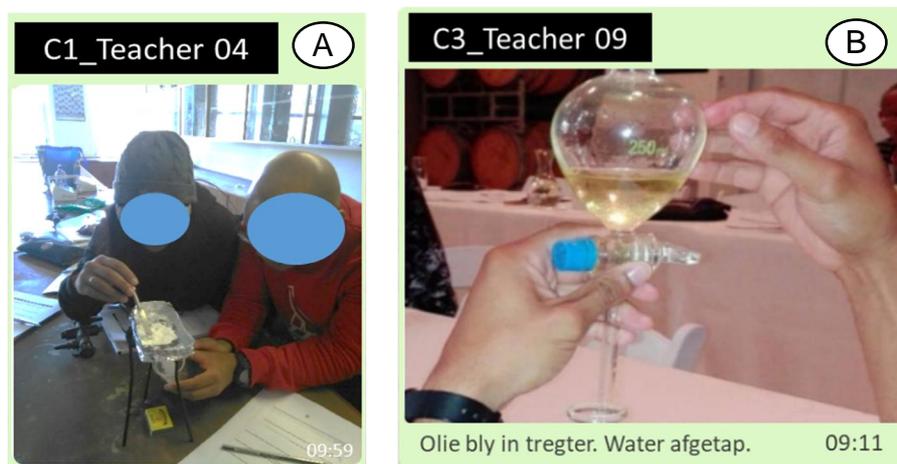


Figure 6.7: Screenshots of examples of the *laboratory skills learning repository* initial theme in Cycle 1 (A) and Cycle 3⁵⁴ (B).

The initial theme *laboratory skills learning repository* resonates with Habash's (2019) argument that experiential learning through the sharing of skills within VCoPs, enhances students' own understanding and knowledge creation within practical courses. This argument clearly has its roots in social constructivist knowledge creation, and its extended connectivist factor of networking.

Looking back at the different initial themes, it became clear that these themes could be combined into 3 main themes: *inclusive learning*, *interactive learning* and *learning repository*. The initial theme *inclusive formative assessment* was merged into *inclusive learning*, as formative assessment is assessment for learning, and therefore supports inclusive learning. This main theme also speaks to this study's grounding learning theory, the social constructivism, extended through the connectivist factors of autonomy, connectedness, diversity and openness. The VCoPs created a social virtual space, within

⁵⁴ Translation: Oil stays in funnel. Water is drained.

which participants could experience the positive autonomy, connectedness, diversity and openness that they needed to support their learning, and that they might not have experienced in an offline CoP. This finding concurs with Grabher and Ibert's (2014) argument that VCoPs afford unique social dynamics that might even be unattainable in f-2-f contexts. The initial themes *interactive problem solving* and *interactive broadcasting* were combined into *interactive learning*, as learning was the main outcome of both initial themes. All the initial repository themes were combined into the main theme *learning repository*, as each of them supported learning. Table 6.3 is a summary of the themes found in each cycle.

Table 6.3:

A summary of the main and initial themes, linked to teacher learning in the TPL short course, found in each cycle.

Main themes	Initial Themes	Cycle 1		Cycle 2		Cycle 3	
		Sub-categories					
		TPL	WA	TPL	WA	TPL	WA
Inclusive learning	Inclusive learning	✓			✓		✓
	Inclusive formative assessment	✓			✓		✓
Interactive learning	Interactive problem solving				✓		
	Interactive broadcasting	✓				✓	
Learning repository	Content learnings repository	✓				✓	
	Summative assessment repository	✓					
	Methods learnings repository	✓				✓	✓
	Laboratory skills repository	✓				✓	✓

6.3.2.2 Design principles for VCoPs that support teacher learning in a TPL programme

In answer to sub-research question 3, the researcher identified three main ways in which VCoPs could support teacher learning in TPL short courses. All three cycles effectively supported inclusive learning. All three cycles also supported interactive learning, but in different ways. Cycle 2, the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, effectively supported the interactive problem-solving component of interactive learning. Cycles 1 and 3 effectively supported interactivity in broadcasted sessions. Cycles 1 and 3 both acted as learning repositories.

It was found that, for a VCoP to be useful as a learning repository for participants in a TPL short course, it should be created before the start of the contact sessions (e.g. Cycles 1

and 3). Design principle 1 already addresses this need and this finding can therefore be seen as an extension of Design principle 1. Design principle 6 is to ensure that facilitators are familiar with the affordance of a VCoP to act as a summative assessment repository. Interactive problem-solving only took place in Cycle 2, the facilitated structured VCoP that aligned with the andragogical approach of self-directedness. Design principle 7 is therefore that a facilitated structured VCoP that aligns with the androgological approach of self-directedness, supports problem-solving in VCoPs most effectively. Neither Cycle 1, the minimally structured VCoP that aligned with the heutagogical approach of self-determination, nor Cycle 3, the highly structured VCoP that aligned with the pedagogical approach of lecture determination, supported interactive problem-solving. Design principle 8 is for facilitators to use the VCoP to increase interactivity in broadcast lessons. All three cycles could, theoretically, have supported interactivity. In the case of Cycle 2, however, the TPL short course did not include a broadcast session. All three cycles supported inclusive learning and Design principle 9 is therefore to ensure that facilitators are aware that a VCoP can assist them in creating a more inclusive learning and assessment environment. A summary of the five design principles, linked to sub-research question 3, emerging from the framework analysis can be found in Table 6.4.

Table 6.4:

A summary of the five design principles of VCoPs that support teacher learning in a TPL short course effectivity (sub-research question 3), emerging from the thematic framework analysis.

Design principle #	Description of design principle
1 (extended)	<ul style="list-style-type: none"> The VCoP should be created well ahead of the first contact session <ul style="list-style-type: none"> to be useful as a platform that communicates logistics to be useful as a learning repository for participants in a TPL short course Participants should also not be part of separate VCoPs with facilitators in the course.
6	<ul style="list-style-type: none"> The service provider of the TPL short course should ensure that facilitators in the VCoP are familiar with its affordance to act as a summative assessment repository.
7	<ul style="list-style-type: none"> A facilitated structured VCoP, that aligns with the andragogical approach of self-directedness, supports problem-solving in VCoPs most effectively.
8	<ul style="list-style-type: none"> The service provider of the TPL short course should ensure that facilitators in the VCoP are aware that it can be utilised to increase interactivity for broadcasted lessons.
9	<ul style="list-style-type: none"> The service provider of the TPL short course should ensure that facilitators in the VCoP are aware that it can create a more inclusive learning and assessment environment.

6.3.3 The ways in which each VCoP provided organisational support for TPL short courses

Sub-research question 4 asked in which ways each WhatsApp VCoP provided organisational support to teachers in the TPL short courses. This sub-research question is informed by level 3 of Guskey's (2002) five levels of determining the effectiveness of professional development programmes: organisational support and change. Sub-research question 4 can be broken down further into two focus questions. Firstly, from the WhatsApp group messages, was there any evidence of SUNCEP providing organisational support and change characteristics (necessary for student success) in the VCoPs? Then, from the WhatsApp group messages, interviews and the qualitative question in the survey, did the participants in the VCoPs perceive organisational support from SUNCEP? These two focus questions formed the two sub-categories for the framework analysis: (i) SUNCEP organisational support and change characteristics and (ii) Participant perception of SUNCEP organisational support characteristics. Six *a priori* codes, linking to Guskey's (2002) descriptors of organisational support, were used to code the data.

For the first descriptor, encouragement or support of student learning, the code #support_learning and the variables ##requested, ##given or ##perceived, were used. For the second descriptor, encouragement or support of student change at an individual level, the code #support_change was used.

For the third descriptor, students receiving sufficient resources, the code #resources was used. For the fourth descriptor, sharing of course relevant material/activities, the code #sharing_material and the variables ##requested and ##given, were used. For the fifth descriptor, reflecting on course material/activities or reflecting on implementation in the classroom, the code #reflection was used.

For the final descriptor, recognition and sharing of student success, the code #recognise-success was used. No data-driven codes emerged during the "identifying the analytical framework" stage of analysis. After indexing the WhatsApp group messages with all six codes across the three cycles, different themes emerged from the mapping matrix.

6.3.3.1 Evidence of SUNCEP organisational support and change characteristics in each VCoP

Guskey's (2002) first descriptor of organisational support and change, encouragement or support of student learning, mapped to three organisational support and change characteristics in Cycle 1: *ICT skills*, *authentic curriculum* and *assignment completion*. In Cycle 1, SUNCEP supplied participants with a tablet with the course material preloaded. ICT skills support mainly focussed on the researcher or other facilitators assisting participants to access the course material, or on how to copy it to their other devices, for example:

WhatsApp message:

C1_Facilitator 01: *Copy it onto your flash drive. Don't remove or cut it from the tablet. Then copy it to your PC.*

The theme *authentic curriculum* refers to the use of participant related, authentic contexts in teaching events, or referring participants to real-life resources that link to the course activities. During Cycle 1 a United States of America National Aeronautics and Space Administration (NASA) spaceship had travelled past the planet Pluto, an event that linked to the TPL course content. C1_Facilitator 01 posted about it to the WhatsApp group:

C1_Facilitator 01: *It is expected for a spaceship to do a flyby past Pluto tomorrow. It took the spaceship 9 years to reach Pluto since it has been launched from NASA on earth! Google search Pluto flyby to read more if you are interested.*

As for the theme *assignment completion*, participants needed support on the exact scope of the assignments. Participants needed support, especially with the assignment that accompanied the self-study e-lesson which had been pre-loaded on their tablets. Below is an example of a researcher response message:

Researcher: *A mind map of the solar system with as much information as you learned from the E-Lesson text and videos as possible.*

In Cycle 2, encouragement or support of student learning mapped to five themes. *ICT skills* and *authentic curriculum*, from Cycle 1, also made appearances in this cycle. The new themes that emerged were *concept clarification*, *addressing misconceptions*, and *learner assessment support*.

Cycle 2 participants did not receive tablets. Their main ICT support needs linked to using WhatsApp functionalities. For example, several participants requested support on how to attach a document to a WhatsApp message (Figure 6.8).

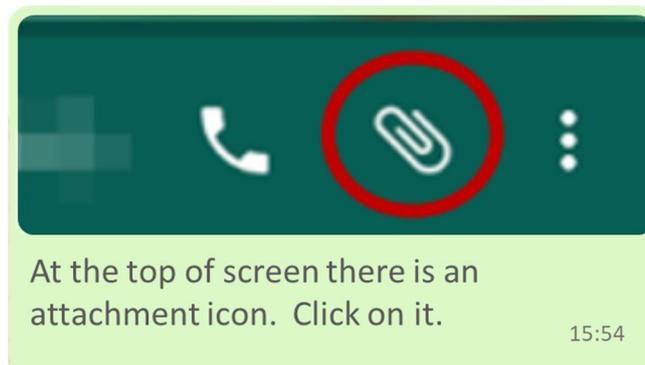


Figure 6.8: Screenshot of one of the researcher posts explaining how to attach a document in WhatsApp (Theme: *ICT skills*).

As an example of the theme *authentic curriculum* in Cycle 2, participants were provided with a link to a video resource that presents a very abstract concept in the Life Sciences TPL course. The video presented a life-like animation of the phases of meiosis that take place in human females (Figure 6.9).



Figure 6.9: Screenshot of the video resource posted by the researcher to support participant conceptualisation with an authentic visualisation (Theme *authentic curriculum*).

The third theme, *concept clarification*, refers to posts made by the SUNCEP facilitators or researcher in answer to conceptual questions asked by participants. In one instance a participant had asked what the differences between two genetic concepts were. The researcher's explanation was mapped to *concept clarification*:

WhatsApp message:

Researcher: *Homozygous and heterozygous has to do with having identical or different alleles. Dominance has to do with how and when an allele is expressed in the phenotype. 😊*

Where the researcher or facilitators picked up conceptual misconceptions among participants, their responses were mapped to *addressing misconceptions*. One misconception related to participants confusing traits with alleles, leading to a second misconception that a trait could be dominant at times and recessive at others. WhatsApp's camera functionality gave the researcher the option to write down a lengthy explanation,

and to post a photo of it on the group. The photo of this written explanation is presented in Figure 6.10.

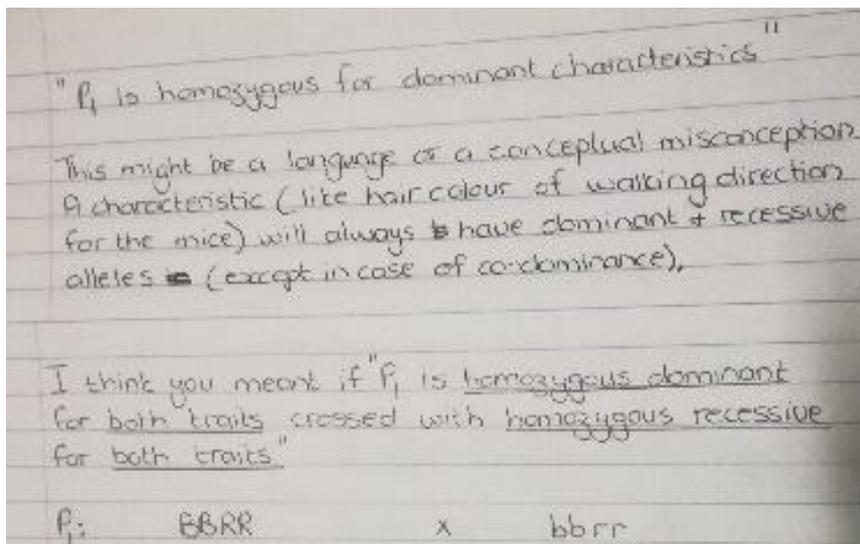


Figure 6.10: Photo of an explanation that was posted by the researcher to address a participant's misconception (Theme: *addressing misconceptions*).

Teachers need to understand how learners will be assessed in the National Senior Certificate (NSC) exam, to prepare them accordingly. Posts that linked to facilitators or the researcher giving input in this regard, were mapped to the theme *learner assessment support*. In Cycle 2 a participant, for example, wanted to know why learners should use Punnett diagrams when drawing genetic crosses. The researcher's response was deemed an example of *learner assessment support*:

WhatsApp message:

Researcher: A Punnett diagram is always the easiest and safest way to avoid mistakes, 😊 because then you can't miss a gamete.

In Cycle 3, encouragement or support of student learning mapped to four of the themes found in the previous cycles: *ICT skills*, *authentic curriculum*, *concept clarification* and *addressing misconceptions*. No new themes, linked to encouragement or support of student learning, emerged.

As in Cycle 2, no tablets were given to the participants in Cycle 3. Course material was handed to participants on USB flash drives. All the posts mapping to the theme *ICT skills* linked to supporting participants to access the TPL short course material. One example linked to participants struggling to find specific documents within folders on the USB flash drive. The researcher's response, the posting of a screenshot from the file explorer view of the USB flash drive with step-by-step instructions, was mapped to the theme *ICT skills*. (Figure 6.11).



Figure 6.11: Screenshot of the first step in a list of instructions to a participant (Theme: *ICT skills*).

In Cycle 3 many of the participants lived in wine farming communities. An example of the theme *authentic curriculum* links to C3_Mentor, who demonstrated the separation of mixtures by means of condensation. C3_Mentor extracted the alcohol from a clear spirit that was produced from grapes from the area (Figure 6.12). All other practical activities in Cycle 3, where resources that were readily available to the participants were used, also mapped to this theme.

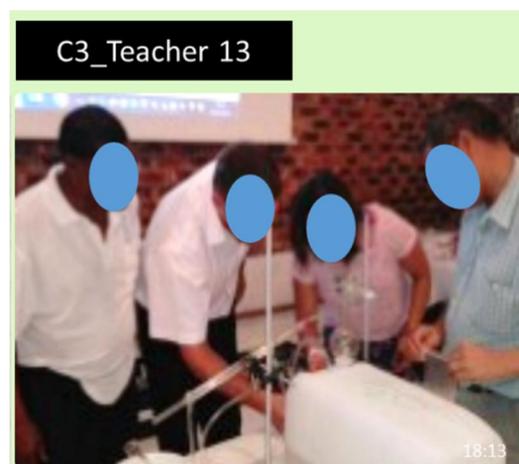


Figure 6.12: A screenshot of a post by C3_Teacher 13 showing the participants assisting C3_Mentor to setup the Liebig condenser to distil pure alcohol from a locally produced clear spirit. (Theme: *authentic curriculum*).

An example of a post mapping to *addressing misconceptions* in Cycle 3 occurred when C3_Teacher 09 heard a fellow participant voicing a misconception during a contact session demonstration. The operation of a separation funnel was demonstrated by C3_Teacher 02 and, although one could see the oil staying in the funnel, a participant thought that the oil was being drained. The researcher asked C3_Teacher 09 to post a photo of the separation funnel with only the oil remaining inside (Figure 6.13).

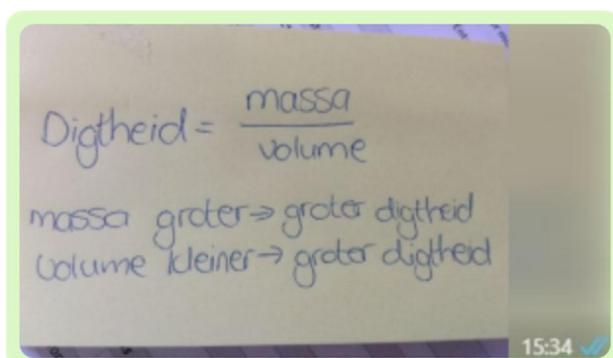


Figure 6.13: A screenshot of C3_Teacher 09's post that aimed to address a misconception during a demonstration. (Theme: *addressing misconceptions*)⁵⁵.

During the second contact session of Cycle 3, participants struggled with the concept of density. After posting images and a link to a video clip about density, the researcher posted an image of a rubber duck bath toy. She then asked the participants to describe ways in which this duck could be made to sink in a bathtub that was filled with water. The participants enjoyed the challenge, pretending in most of their answers that the duck was a living organism. C3_Teacher 02 suggested the duck eat a lot of sand, as it is hollow and will therefore increase the ducks overall density. This was a good answer and the researcher responded with two *concept clarification* posts (one text and one photo) to ensure that all participants understood this answer.

WhatsApp message:

Researcher: C3_Teacher 02, dis 'n baie goeie antwoord. Deur die massa meer te maak word die digtheid meer en kan die eendjie dus sink. [Translation: C3_Teacher 02, that is a very good answer. By increasing the mass the density is increased and therefore the duck can sink.]



Translation:

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Mass larger → higher density

Volume smaller → higher density

Figure 6.14: Screenshot of the researcher's post, clarifying the concept of density (Theme: *concept clarification*).

⁵⁵ Translation: Oil stays in funnel. Water is drained.

In summary, all three cycles showed elements of encouragement or support of student learning, Guskey's (2002) first descriptor of organisational support and change. All the themes that emerged from the encouragement or support of student learning descriptor also speak to the support of TSPCK as necessary component to develop the Nature of Science (NOS) in TPL short courses (Rollnick & Davidowitz, 2015). Cycle 1, with the minimally structured VCoP that aligned with the heutagogical approach of self-determination, supported participants in three ways: by supporting their ICT skills, by presenting them with authentic curriculum content and activities and by providing support to participants to complete assignments by, for example, clarifying the scope for them. In Cycle 2, the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, participants were supported in five different ways. As in Cycle 1, Cycle 2 supported ICT skills and authentic curriculum delivery. Cycle 2 also supported concept clarification, addressed topic misconceptions and prepared participants to support their learners for assessment. Cycle 3, the highly structured VCoP in which researcher resource input was concept and time aligned with the TPL course (pedagogical approach of lecture determination), showed four themes also found in Cycle 2. Cycle 3 supported participants' ICT skills, delivered authentic curriculum activities, supported concept clarification and addressed topic misconceptions. Cycle 2 therefore showed the most elements of encouragement or support of student learning.

Guskey's (2002) second descriptor of organisational support and change, encouragement or support of student change at an individual level, only mapped to one conversation in Cycle 2. A participant had complained that the TPL course content had moved outside of the CAPS curriculum. The researcher, C2_NCED and other participants joined in the conversation. The WhatsApp message of the researcher, as SUNCEP facilitator on the course, was mapped to encouragement or support of student change at an individual level:

Researcher:	<i>It's not always just about what to teach, but also how teachers understand the topic. And some topics can be very challenging. We often find that learners will Google when they do not understand the textbook or the teacher. As teachers we need to attempt to understand the topic fully, even if we only teach to the exam guideline. South Africa needs critically thinking learners and teachers.</i>
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Guskey's (2002) third descriptor of organisational support and change, students receiving sufficient resources, could only be measured by student perception and therefore resorts under the second focus question.

The fourth Guskey (2002) descriptor of organisational support and change is sharing of course relevant material/activities. In Cycle 1, apart from images and videos from the contact sessions, the researcher shared CAPS documents and School Based Assessment (SBA) tasks with the participants. In Cycle 2, apart from the vignettes and quizzes, most of the material shared were websites with old exam papers or laboratory procedures. In Cycle 3 the researcher and facilitators also shared videos, images and internet links to more resources and lab equipment suppliers.

WhatsApp messages:

Cycle 1: Researcher: 📣📣 Good morning. Would anyone be interested in exemplar Gr 8&9 SBA tasks for term 3? The SA for Eden Karoo shared her material with us. :)

Cycle 2: Researcher: You can find old exam papers at:
[http://www.education.gov.za/Curriculum/NationalSeniorCertificate\(NSC\)Examinations/NSCPastExaminationpapers.aspx](http://www.education.gov.za/Curriculum/NationalSeniorCertificate(NSC)Examinations/NSCPastExaminationpapers.aspx)

Cycle 3: Facilitator 01: <https://iupac.org/what-we-do/periodic-table-of-elements/> Die nuutste, warm uit die oond Periodieke Tabel [Translation: The newest, hot of the presses, Periodic Table]

The fifth Guskey (2002) descriptor of organisational support and change, reflecting on course material/activities or reflecting on implementation in the classroom, is also linked to student perception and therefore resorts under the second focus question.

The last Guskey (2002) descriptor of organisational support and change, recognition and sharing of student success, was evident in all three cycles. In Cycle 1 most of the recognition posts consisted of positive emoji's or short phrases in answer to student posts. In Cycle 2 the researcher made an adjustment by posting more descriptive recognition messages. In Cycle 3 recognition was expanded to the sharing of privately posted correct answers, with permission, to the group. Examples from Cycles 1 and 2 can be seen in the quotes below and for Cycle 3 in Figure 6.15.

Cycle 1: Researcher: *LOVELY! Scientific Literacy IN ACTION :)*

and 😊😊😊👍👍

Cycle 2: Researcher: *I want to thank C2_Teacher 19 for sharing this interesting question with the group 😊. And for everyone who were brave enough to join in on the conversation! That was a real professional learning moment.*

and *Hi everyone. I'm very impressed with how you all jumped in and discussed this problem 🙌🙌🙌🙌🙌🙌. That's what the DBE meant when they proposed that teachers form PLCs (Professional Learning Communities)*

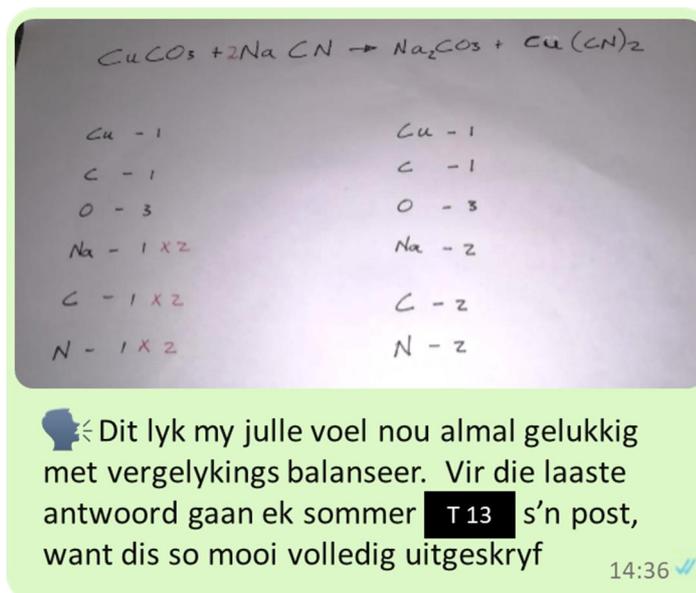


Figure 6.15: Guskey's (2002) sixth descriptor of organisational support and change, recognition and sharing of student success, in Cycle 3⁵⁶.

The first focus question asked: From the WhatsApp group messages, were there evidence of SUNCEP providing organisational support and change characteristics necessary for student success in the VCoP? Evidence of SUNCEP providing organisational support and change characteristics were present in all three cycles. Cycle 2, the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, was most effective in providing organisational support and change characteristics. It supported encouragement of student learning through supporting ICT skills, delivery of authentic curriculum, concept clarification, addressing misconceptions and offering learner assessment support. Cycle 2 also supported student change at an individual level, sharing of course relevant material and activities, and the recognition and sharing of student success. Cycle 3, the VCoP that was highly structured and in which researcher resource inputs were concept and time aligned with the TPL course (pedagogical approach of lecture determination), also fared well. Cycle 3 did however not support learner assessment or student change at an individual level. Cycle 1 was deemed the least effective in providing organisational support and change characteristics. A summary of organisational support and change characteristics provided by SUNCEP in each VCoP, can be seen in Table 6.5.

⁵⁶ Translation: It seems to me that all of you are now happy with balancing equations. For the last answer I am going to share C3_Teacher 13's answer, because it was so nicely written out in full.

Table 6.5:

Evidence of SUNCEP providing organisational support and change characteristics in each cycle's VCoP, ordered by Guskey (2002) descriptors.

Guskey (2002) descriptors	Organisational support and change characteristics	Cycle 1	Cycle 2	Cycle 3
Encouragement or support of student learning	Supporting ICT skills	✓	✓	✓
	Authentic curriculum delivery	✓	✓	✓
	Concept clarification		✓	✓
	Addressing topic misconception		✓	✓
	Learner assessment support		✓	
Encouragement or support of student change at individual level	Encouragement or support of student change at individual level		✓	
Sharing of course relevant material/activities	Sharing of course relevant material/activities	✓	✓	✓
Recognition and sharing of student success	Recognition and sharing of student success	✓	✓	✓

6.3.3.2 Participant perception of SUNCEP organisational support characteristics in each VCoP

Focus question 2 asked: Did the participants of the WhatsApp groups perceive organisational support from SUNCEP? As for Guskey's (2002) first descriptor of organisational support and change, encouragement or support of student learning, two themes emerged from Cycle 1: (i) *general learning support* and (ii) *broadcast learning support*. Examples of the perception of *general learning support* in Cycle 1 were found in interview comments and the survey:

Interview:

C1_Teacher 16: *Sien...as ek nou net terugdink aan...uhm...uhm... die...verskillende vlakke waarop leerders leer...as ek dink aan...uhm... verskillende strategieë. Hoe ons leerders op hulle vlak...uhm...kan teach...uhm en al daai content en pedagogy het vir ons...en vir my persoonlik...baie gehelp.* [Translation: See, when I think back to the different levels at which learners learn, the different strategies. How we can teach learners at their level and all the content and pedagogy...for me personally it helped a lot.]

Survey:

C1_Teacher H: *Absolutely. Learning at my fingertips. Everyone was very open to assist and answer any question.*

Examples of participants' perception of supported learning during the broadcasting session were found in WhatsApp messages posted by participants after the telematics broadcasting session:

WhatsApp message:

C1_Teacher 05: *This session was something else. Learned a lot. Very interesting.*

C1_Teacher 14: *Thanks for this afternoon. Very informative* 👍

Participants in Cycle 2 perceived three support characteristics linked to encouragement or support of student learning: (i) *general learning support*, (ii) *narrowing of transactional distance* and (iii) *creating trust*. Examples of the perception of *general learning support* in Cycle 2 were found in WhatsApp group posts and the interviews:

WhatsApp message:

C2_Teacher 02: *Thanks to you for challenging our brains* 😊.

Interview:

C2_Teacher 16: *Kom ons sê dit wat ons by die kursus byvoorbeeld geleer het...uhm...was maar net verder uitgebrei op die WhatsApp group...* [Translation: I would say what we learned during the course was expanded on in the WhatsApp group]

Narrowing of transactional distance featured in the interviews of Cycle 2, when interviewees were asked whether the WhatsApp group could be seen as active learning, and whether the WhatsApp group enhanced the effectivity of the course. This was an important finding as participants in Cycle 2 lived and taught in the sparsely populated Northern Cape Province, far from each other and from the SUNCEP offices.

Interview:

C2_Teacher 12: *Mens begin so half so later te fokus op CAPS en CAPS dat...uhm...as jy net eers 'n nuwe uitgangspunt gesien het dan verbreed dit half jou jou kennisveld, as jy hoor wat ek sê. Veral ons wat op die platteland, jy weet ons wat op die platteland ons sien een keer 'n kwartaal 'n ander skool se onderwyseres... of so.* [Translation: One tends to eventually focus so much on CAPS that you don't even see a new viewpoint...it broadens your knowledge scope, if you understand me. Especially for us in the rural areas, where we only see another school's teachers once per term]

During Cycle 2's contact session, participants did not interact a lot and were quite shy to speak to one another in physical groups. But after the contact session things changed when the researcher started to post CAPS aligned content on the WhatsApp group. During the interviews, and in the survey, participants commented on trusting the group environment:

Interview:

C2_Teacher 01: *Dit was amazing dat die ouens toe skielik die vrymoedigheid gehad het om te sê maar verduidelik gou-gou hier by die bloedgroepe of verduidelik gou-gou hier by hierdie genetika vraag. Toe skielik het hulle die vrymoedigheid gehad om te sê maar help gou vir my.* [Translation: It was amazing when the participants suddenly had the confidence to say please explain this part of blood groups quickly or this genetics question. Suddenly they had the confidence to ask for help.]

Survey:

C2_Teacher C: *Yes, because I felt that whenever I had problems with the content, I could just ask freely and get an answer.*

Participants in Cycle 3 perceived three support characteristics linked to encouragement or support of student learning: (i) *general learning support*, (ii) *narrowing of transactional distance* and (iii) *creating a trusting environment*. Examples of *general learning support* were found in WhatsApp messages, the interviews and in the survey:

WhatsApp message:

C3_Teacher 09: *Researcher dit was nou baie goeie ondersteuning stap vir stap het jy my gehelp* [Translation: Researcher that was really good support, helping me step-by-step.]

Interview:

C3_Teacher 14: *Vrae wat ek nie kon beantwoord het nie, daar's...julle was baie ondersteunend dink ek.* [Translation: Questions that I could not answer, I think you were very supportive there.]

Survey:

C3_Teacher C: *Ek het verskriklik baie geleer deur die WhatsApp. Sekere goed wat nie by die face-to-face sessies aangespreek of genoem was nie het ons op die groep bespreek.* [Translation: I learned so much through the WhatsApp. Some things that were not addressed or talked about at the face-to-face sessions, we discussed on the group.]

Cycle 3 participants were living and teaching in a rural part of the Western Cape Province and isolated from regular contact with each other and the SUNCEP offices. It was therefore an important finding that participants in this cycle also experienced the WhatsApp group to narrow transactional distance.

Interview:

C3_Teacher 13: *As daar vrae was dan...dan was dit net 'n WhatsApp ver. Of as jy 'n antwoord wil gee, dan is dit net 'n WhatsApp ver, so dit is... dit is nie 'n ding wat lank vat nie. Dit...dit...is 'n vinnige proses.* [Translation: If there were questions, then it was only a WhatsApp away. Or if you wanted to give an answer, then it was only a WhatsApp away. So it is something that doesn't take a long time. It is a quick process.]

Although Cycle 3 participants actively took part in physical group work during contact sessions, few participants actively posted on the WhatsApp group. In an interview with C3_Mentor she proposed that participants might have been scared of exposing themselves

to the group. According to the survey answers though, some participants did perceive the group as creating a trusting environment.

Interview:

C3_Mentor: *Dat hulle bang is om hulle self bloot te stel op so 'n groep. Nou sien jy, maar hulle het aflyn gepraat, ag...hulle het met my persoonlik gepraat. Behalwe 'n paar wat aktief was op die groep, het die ander op my persoonlike WhatsApp vir my gevra van goed wat daar geskryf is. Dis hoekom ek gesê het dit gaan baie oor vertrou. [Translation: That they were scared to expose themselves on the group. You see, they spoke off-line, or rather personally to me. Except for a few that were active on the group, the rest asked their questions personally on my WhatsApp. That is why I said it is a lot about confidence.]*

Survey:

C3_Teacher A: *I felt so comfortable to ask questions and even give answers.*

This was the cycle where C3_Mentor had supported participants in their schools before the TPL short course. It is therefore likely that some participants would have felt more comfortable speaking to her privately than posting to the Cycle 3 WhatsApp group. As their questions to C3_Mentor arose from discussions on the Cycle 3 group, and C3_Mentor was a SUNCEP staff member, they were in effect still indirectly supported by SUNCEP.

One negative perception of learning support surfaced in Cycle 3 when, during an interview, C3_Teacher 01 commented on data costs:

Interviews:

C3_Teacher 01: *Ek sou nie sê...ek kon nie altyd...ek kon nie altyd...ek het nie altyd data gehad nie...om oop te maak nie... en met al hierdie goed...bedrywighede het dit...het ek van die goed gemis. [Translation: I wouldn't say, I couldn't always, I did not always have data to open the things...activities. So I missed some of the stuff.]*

Researcher: *So jy het nie die balansering van vergelykings videos gesien nie? [Translation: So you did not see the balancing of equations videos?]*

C3_Teacher 01: *Nee, nee nie eintlik nie. [Translation: No, not really.]*

WhatsApp has a "Message info" option, where the researcher could see who on a group watched the videos posted by her. C3_Teacher 01 had opened all the videos during the course (Figure 6.16). Before 2019 a video on WhatsApp first had to be downloaded completely to a cell phone, before it could be watched. C3_Teacher 01 might not have realised this and perhaps closed the video just after starting to watch it, thinking that she could save data that way.

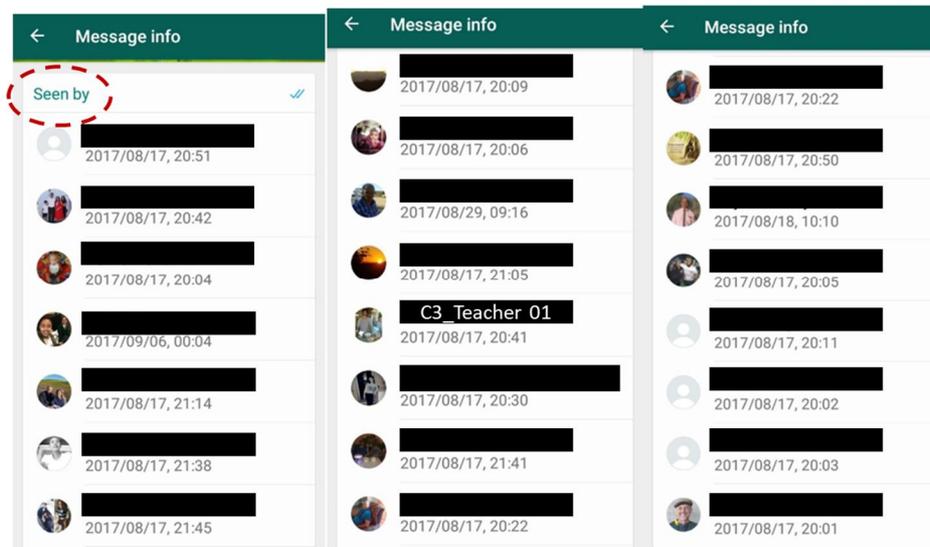


Figure 6.16: Screenshot of the WhatsApp "Message Info" function that shows that C3_Teacher 01 had downloaded and opened a video clip on balancing equations on 2017/08/17 at 20:41.

Participant perception of Guskey's (2002) second descriptor of organisational support and change, encouragement or support of student change at an individual level, was only present in Cycles 1 and 2. During Cycle 1 interviews, participants commented on how they perceived the VCoP to have changed their attitude and approach to teaching (*change in attitude and approach to teaching*) and how they made their new knowledge part of their teaching (*incorporating new knowledge in teaching*):

Interviews:

C1_Teacher 06: *Al het ek nie baie gepraat op die groep nie, het ek heeltemal my benadering verander en my houding teenoor die tema het beslis verander.* [Translation: Although I did not speak much on the group, it totally changed my approach and attitude towards this topic.]

C1_Teacher 13: *Al het jy min gepraat...maar tog het jy dit ter harte geneem... en...dit ook jou eie gemaak om in jou klaskamer te gebruik.* [Translation: Although one spoke little, one still took it to heart and made it your own to use in the classroom.]

Interestingly enough, both these participants were listeners in the VCoP, but they still perceived a change in their teaching due to being a part of the VCoP. This concurs with Crawford (2009) who argues that listeners in online communities are not inactive members, but that they are active members through tracking the posts of others.

During Cycle 2 interviews, participants commented on how they perceived the VCoP to have changed their pedagogy. This was seen as examples of *incorporating new knowledge into teaching*. C2_Teacher 02, for example, commented on how he started to use video clips in

his teaching. C2_Teacher 12 felt that the VCoP had shown her different ways to present her lessons:

Interviews:

C2_Teacher 02: *Uhm...yes...it did change my pedagogy...it made me question myself. So how can I use technology in my classroom...and...use videos and...teach them stuff like that ...to be able to visualize some of the things.*

C2_Teacher 12: *Jy sien ander mense se sienswyses en uhm...hulle manier van iets doen. Veral by 'n skool waar ek skoolgee, soek ek net 'n ander manier om iets aan te bied of anders te stel, kan mens maar sê. So, ja dit het my pedagogie verander. [Translation: You see other people's views and their way of doing things. Especially at the school where I teach, you could say that I need other ways of presenting things or different ways to put things. So yes, it has changed my pedagogy.]*

The third Guskey (2002) descriptor, students' perception of receiving enough resources, was present in all three cycles. Positive reports about receiving enough resources were found in Cycle 1 participants' WhatsApp messages and the interviews. For example, C1_Teacher 10 thanked the researcher for sharing Formative Assessment Tasks (FATs) on the group. In the interviews C1_Teacher 06 commented that the resources had supported him.

WhatsApp message:

C1_Teacher 10: *Thanx for sending the FATs⁵⁷ 👍*

Interview:

C1_Teacher 06: *Die deelname aan hierdie WhatsApp groep, veral al die hulpbronne wat ons gekry het, uhm...dit het regtig waar vir my ondersteun. [Translation: The participation in this WhatsApp group, especially the resources that we received, really supported me.]*

In Cycle 2, positive reports were found in participants' WhatsApp messages, as well as in the interview with C2_NCED. For example, C2_Teacher 09 thanked the researcher for posting an online link to a blood group game for learners, and C2_NCED was impressed with the animations that were posted to the group, showing how the eye works:

WhatsApp message:

C2_Teacher 09: *Thanks for the link to the online game, Researcher.*

Interview:

C2_NCED: *Ek dink aan daai oulike goedjies wat oor die oog verskyn het toe hulle besig was met die oog. [Translation: I am referring to those nice things that were posted about the eye, when they were busy with the eye topic].*

⁵⁷ Formal Assessment Tasks.

In Cycle 3, positive reports of participants' perception of receiving enough resources were only found in the interviews. C3 Teacher 14 commented that he thought the resources were so relevant that he could even share it with another colleague.

Interview:

C3_Teacher 14: *Ja, definitief. Dit was relevant. Ek kon even saam met my kollega wat ook graad 7 onderrig, kon ek toe ook gehelp het.* [Translation: Yes definitely. It was relevant. I could even share it with my colleague who also teaches grade 7.]

The fourth Guskey (2002) descriptor is sharing of course relevant material and activities. In the context of student perception, this descriptor was found to be too close in meaning to the third descriptor and therefore not addressed separately.

Reflecting on course material/activities or reflecting on implementation in the classroom is Guskey's (2002) fifth descriptor of organisational support and change. Reflection was present in all three cycles in the interviews. In Cycle 1, both reflection on course activities and on implementation in the classroom, were found:

Interview:

C1_Teacher 14: *So, jy weet, hierdie was regtig waar vir ons oë ook oopgemaak oor hoe jy dit kan doen...en hoe jy dit kan implementeer in jou les in om dit vir die kinders natuurlik...uhm...uhm...jy weet...baie meer bruikbaar te maak* [Translation: So, you know, this was really an eye opener to us, about how you can do it...how you can implement it in your lesson to make it more user friendly for the learners]

In the Cycle 2 interviews, reflection focussed on implementation in the classroom:

Interview:

C2_Teacher 02: *It was really cool to...see that...you know, ICT can help in the class...teaching Life Sciences.*

In Cycle 3 interviews, reflection on course activities (C3_Teacher 01), on implementation in the classroom (C3_Teacher 14) and on the impact of VCoP discussions (C3_Teacher 13) were found.

Interviews:

C3_Teacher 01: *Ons het dit in groepe gedoen en met die ondersteuning van die medekollegas kon ons rustig deur die stappe gaan en kon ek dit beter begryp. Oorhaastigheid laat mens soms flaters maak.* [Translation: We did it in groups and, with the support of the co-workers, we could calmly work through all the steps and I could get a better understanding. Undue haste causes one to sometimes make blunders.]

C3_Teacher 14: *Ek gebruik die materiaal in die klaskamer, en ...met so bietjie aanpassing ook. Die vlak is partykeer mos nou ook hoër, graad 8 of 9 vlak...so ons stop mos nou maar by graad 7.* [Translation: I use the material in the classroom, with a bit of adaptation, as the level is sometimes a bit higher, grade 8 or 9 level. We stop at grade 7.]

C3_Teacher 13: *Dis leersaam om ander se menings te hoor en...uhm...joune dan nou daarmee te vergelyk en te sien is jy darem in die kol of...of sit jy nou die pot heeltemal mis.* [Translation: It is informative to hear others' opinions and... to then compare them with yours, to see if you are on track... or if you missed the plot completely.]

Wesley and Buysse (2001) comment on the volumes of literature devoted to the benefits of reflection for teaching professionals. They highlight that reflection within CoPs assists teachers in classifying their own, and others', teaching methods and approaches in terms of effectiveness. Wesley and Buysse (2001) also argue that reflection assists teachers to reframe their own assumptions about their own familiar practices. Both these benefits of reflection emerged from the interview with C3_Teacher 13. Reflection is also a key component of both PCK and TSPCK (Rollnick & Davidowitz, 2015; Shulman, 1987). Some participants were only listeners in the Cycle 3 VCoP, but voiced their opinions directly to the C3_Mentor. The C3_Mentor was therefore also interviewed to determine what her perception of participant reflection was. She was of the opinion that the whole process of interacting on two virtual spaces had enhanced the learning process.

Interview:
C3_Mentor: *Deur die hele proses, dit wat vir hulle gegee word of dit wat gepost word, word hulle gekonfronteer om te dink...hulle moet reflekteer op dit...hulle eie kennis wat hulle het, moet hulle weer oor besin...en hulle ondervinding...en deur daai hele proses, bietjie kommunikasie op die groep en dan ook af van die groep af, het hulle uit die proses geleer.* [Translation: Through the whole process, that which was given to them or that which was posted, they were confronted to think. They had to reflect on it. They had to rethink their own knowledge and experience. Through that whole process, the bit of communication on the group, and then also off the group, they learned.]

C3_Mentor's opinions are also congruent with Wesley and Buysse's (2001) argument that reflection assists teachers to reframe their own assumptions about their own familiar practices. The final Guskey (2002) descriptor, recognition and sharing of student success, did not emerge as a participant perception in any cycle.

The second focus question asked: Did the participants of the WhatsApp groups perceive organisational support from SUNCEP? Participants in Cycles 1 and 2's VCoPs perceived organisational support characteristics in four of the Guskey (2002) descriptors, while Cycle 3 VCoP participants only perceived organisational support characteristics in two of the Guskey (2002) descriptors. Participants in Cycle 1 perceived encouragement or support of student learning through general learning support and broadcast learning support. They perceived encouragement or support of student change through a change in attitude and approaches

to their own teaching, or through being able to incorporate new concepts in their teaching. Cycle 1 participants also perceived that they received enough resources and that they reflected on course materials/activities, and on the implementation thereof in the classroom. Participants in Cycle 2 perceived encouragement or support of student learning through general learning support, narrowing of transactional distance and the creation of a trusting environment within their VCoP. They perceived encouragement or support of student change through a change in their pedagogy. Cycle 2 participants were also of the perception that they received enough resources and that they reflected on the implementation of course material/activities in the classroom. Cycle 3 participants did not perceive encouragement or support of student change. They did comment on receiving enough resources, reflected on course materials/activities and their implementation, and reflected on their assumptions about the teaching practices they utilised. A summary of organisational support characteristics perceived by participants in each VCoP can be seen in Table 6.6.

Table 6.6:
Participants' perception of SUNCEP organisational support characteristics in each VCoP

Guskey (2002) descriptors	Organisational support and change characteristics	Cy cle	Cy cle	Cy cle
Encouragement or support of student learning	General learning support	✓	✓	✓
	Broadcast learning support	✓		
	Narrowing of transactional distance		✓	✓
	Creating a trusting environment		✓	✓
Encouragement or support of student change	Change in attitude and approach to teaching	✓	✓	
	Incorporating new knowledge in teaching	✓		
Resources	Receiving enough resources	✓	✓	✓
Reflection	Course material/activities	✓		✓
	Implementation in the classroom	✓	✓	✓
	Assumptions about own teaching practice			✓

6.3.3.3 Design principles for VCoPs that provide organisational support and change in a TPL short course

To answer in what ways each WhatsApp VCoP provided support to teachers in TPL short courses (sub-research question 4), the question was split into two focus questions. The first asked if there was any evidence of SUNCEP providing organisational support and change characteristics in the VCoPs. The second asked whether VCoP participants perceived organisational support from SUNCEP. Of the six Guskey (2002) descriptors of

organisational support and change, characteristics within four descriptors were identified as ways in which the VCoP cycles could possibly provide organisational support: (i) encouragement or support of student learning, (ii) encouragement or support of student change at individual level, (iii) sharing of course relevant material/activities and (iv) recognition and sharing of student success. Four descriptors were also identified as ways in which participants could possibly perceive organisational support: (i) encouragement or support of student learning, (ii) encouragement or support of student change at an individual level, (iii) perception of receiving enough resources and (iv) reflecting on course material or implementation thereof in the classroom.

In Cycle 2, the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, evidence of SUNCEP providing support characteristics in the VCoP linked to all four proposed provision descriptors (focus question 1). Cycle 2 also showed participant perception of SUNCEP support characteristics for all four proposed perception descriptors (focus question 2). Cycles 1 and 3 each provided support characteristics linked to three of the four proposed provision descriptors (focus question 1). Cycle 1 showed participant perception of support characteristics linked to all four proposed perception descriptors, while Cycle 3 showed participant perception of support characteristics linked to three of the proposed perception descriptors (focus question 2). Therefore, Cycle 2 was most effective as organisational support and change platform. The fact that a facilitated structured VCoP, that aligned with the andragogical approach of self-directedness, provides organisational support and change more effectively than the other two types of VCoPs, can be seen as an extension of Design principle 7. To determine more design principles, a deeper look into the different descriptors was needed.

For the first Guskey (2002) descriptor, Cycles 2 and 3 were both effective in providing encouragement or support of student learning through supporting ICT skills development, delivering authentic curriculum, supporting concept clarification and addressing topic misconceptions. Cycle 2 also provided learner assessment support. Cycle 1 only supported ICT skills development and the delivery of authentic curriculum. Encouragement or support of student learning characteristics can therefore be part of a VCoP, as seen in Cycles 2 and 3, but it is not an intrinsic characteristic, as seen in Cycle 1. Design principle 10 is therefore that, in order to provide encouragement or support of student learning characteristics, a VCoP must be actively designed to include those characteristics.

It should be noted that the participant perception of encouragement or support of student learning, linked to different characteristics than those deemed provided. Cycles 2 and 3 were perceived as providing general learning support, narrowing transactional distance and creating a trusting environment. The participants in Cycle 1 only perceived general learning support and learning support during broadcasts. Although the characteristics perceived were different, participants still deemed both Cycles 2 and 3 as effective in providing encouragement or support of student learning characteristics, in line with the finding in the previous paragraph.

As for encouragement or support of student change at an individual level, the second Guskey (2002) descriptor, only Cycle 2 showed evidence of focussed provision of this kind of support. However, participants in both Cycles 1 and 2 were of the perception that the VCoPs encouraged student change at an individual level. Encouragement or support of student change at an individual level can therefore be part of a VCoP, as perceived in Cycles 1 and 2, but is not intrinsically part of a VCoP, as seen in Cycle 3. It would seem that it was easier for participants to perceive change in the minimally or facilitated structured VCoPs than in the highly structured VCoP. In order to provide encouragement or support of student change at an individual level, a VCoP must therefore be actively designed to include those characteristics. This is an extension of Design principle 10.

The third Guskey (2002) descriptor, students receiving sufficient resources, and the fourth descriptor, sharing of course relevant material/activities, are interlinked. For students to have a perception of receiving sufficient resources, course relevant material/activities should have been provided in each VCoP. From both the provision and perception level, all three cycles showed evidence of providing course relevant material/activities, and receiving sufficient resources. Design principle 11 is that the structure of the VCoP has little influence on the sharing of course relevant material/activities and the perception of receiving sufficient resources.

Reflecting on course material/activities or reflecting on implementation in the classroom, the fifth Guskey (2002) descriptor, only linked to participant perceptions in the interviews. In Cycle 3 participants reflected on three aspects: Course material/activities, implementation of activities in the classroom and assumptions about the teaching practices they utilised. In Cycle 1 participants reflected on two aspects: course material/activities and implementation of activities in the classroom. In Cycle 2 participants only reflected on the implementation

of activities in the classroom. In all cycles, participants reflected on the implementation of activities in the classroom, which is a positive finding. Cycle 3 was the cycle in which participants had operated across two virtual spaces, the VCoP and the private WhatsApp communication with the mentor/facilitator. The researcher can therefore not conclusively link the effectiveness of Cycle 3 in supporting reflection, to the structure of the VCoP. No new design principle emerges, as these findings link to the part of Design principle 1 that argues that participants should not be part of separate VCoPs with facilitators on the course.

The last Guskey (2002) descriptor of organisational support, recognition and sharing of student success, only featured as a provision of the organisational support descriptor, and featured in all three cycles. All three VCoP structures supported recognition and sharing of student success. This can be seen as an extension of Design principle 11. In other words, programme structure of the VCoP has little influence on recognition of success. A summary of the three design principles, linked to sub-research question 4, emerging from the thematic framework analysis can be found in Table 6.7.

Table 6.7:

A summary of the three design principles of VCoPs that effectively provide organisational support and change in TPL short courses (sub-research question 4), emerging from the thematic framework analysis.

Design principle #	Description of design principle
7 (extended)	<ul style="list-style-type: none"> • A facilitated structured VCoP that aligns with the andragogical approach of self-directedness most effectively: <ul style="list-style-type: none"> ○ provides organisational support, and ○ supports problem-solving in VCoPs.
10	<ul style="list-style-type: none"> • VCoPs do not intrinsically support encouragement, or support of learning or learner change, but VCoPs have to be actively designed to include those characteristics.
11	<ul style="list-style-type: none"> • The programme structure of the VCoP has little influence on the following organisational support indicators: <ul style="list-style-type: none"> ○ the sharing of course relevant material/activities, ○ the perception of receiving sufficient resources, and ○ recognition of success.

6.3.4 The ways in which each VCoP supported implementation of TPL programme content knowledge and skills

Sub-research question 5 asked in which ways each WhatsApp VCoP supported participants to implement TPL short course content knowledge and skills in their teaching contexts. This sub-research question is informed by level 4 of Guskey's (2002) five levels of determining

the effectiveness of professional development programmes: participants' use of new knowledge and skills. Two *a priori* codes, linking to Guskey's (2002) descriptors of implementation support, were used to code the data: #same (demonstrations of identical or similar implementation of course activities) and #adapted (demonstrations of adapted implementation of course activities). No data-driven codes emerged during the "identifying the analytical framework" stage of analysis. After indexing the WhatsApp group messages with both these codes across the three cycles, different themes emerged from the mapping matrix.

6.3.4.1 Implementation support via VCoPs in the TPL short courses - themes emerging from the thematic framework analysis

From the thematic framework analysis, two main themes emerged: (i) *VCoP as support* and (ii) *VCoP as reporting platform*. *VCoP as support* refers to a VCoP providing support to participants when they encounter implementation issues. This theme was only found in Cycle 1, but across all three data groups (WhatsApp messages, interviews and the survey). One example was C1_Teacher 07 who wanted to use an interactive lesson from the TPL short course, but she thought the sound had disappeared. The researcher could inform her that the lesson did not have sound. C1_Teacher 46 commented on how she received instructions to fix an experiment that she could not get to work correctly. In the survey, C1_Teacher D related how she could request apparatus from colleagues on the group:

WhatsApp message:

C1_Teacher 07: *Researcher, jammer oor die dom vraag. Ek wil die interaktiewe eenheid 1 les nou vir my Astroqiz-leerders speel, maar die klank wil nie werk nie. Was daar klank?* [Translation: Researcher, sorry for the stupid question. I want to do the interactive unit 1 lesson with my Astrouquiz learners, but the sound doesn't work. Was there sound?]

Researcher: *Nee C1_Teacher 07, daardie les het nie klank nie.* [Translation: No, that lesson does not have sound]

Interview:

C1_Teacher 46: *Ek het byvoorbeeld die kleurpigment eksperiment gedoen toe werk my koki's nie. Toe vra ek wat moet ek doen. Toe sê jy of iemand vir my...uhm...maar die koki's moet 'n waterbasis hê...uhm...om te sien hoe die swart verdeel in verskillende kleure.* [Translation: For example, I did the colour pigment experiment, but my kokis did not work. I asked what I should do and then you or someone said that the kokis had to be water soluble to see how the black separates into different colours.]

Survey

C1_Teacher D: *Ek kon maklik met enige van die fasiliteerders of ander kollegas in verbinding tree oor enige probleem, of as ek apparaat nodig gehad het vir eksperimente.*
 [Translation: I could easily contact any of the facilitators or other colleagues on any problem, or if I needed apparatus for experiments.]

The theme *VCoP as reporting platform* refers to evidence of implementation being posted to a VCoP. Evidence of this theme was found in all three cycles, but most extensively in Cycle 3, where the facilitator/mentor had taken photos during her mentoring visits, and at the request of the students had posted it to the VCoP. There were therefore posts of implementation for each student in the VCoP. In Cycle 1 the mentors took photos and posted some of them during mentoring visits, but not nearly as extensive as in Cycle 3. Cycle 2 did not have physical mentoring support after the contact session and very few implementation events were reported in this VCoP. In the interviews C2_Teacher 02 referred to this:

C2_Teacher 02: *The people did not engage very well on sharing implementation.*

The theme *VCoP as reporting platform* had two sub-themes: (i) *duplication* and (ii) *adaptation*. *Duplication* refers to the implementation being identical or similar to that experienced by the student during the TPL short course. An example of *duplication* was found in Cycle 1 when C1_Teacher 09 posted a photo of a learner investigating the electrolysis process in the same way the students investigated it in the TPL contact session (Figure 6.17).



Figure 6.17: Screenshot of a post in Cycle 1, where a learner is repeating an investigation from the TPL short course, as an example of the theme *duplication*.⁵⁸

⁵⁸ Translation: Busy with the electrolysis process.

In Cycle 2 only verbal reporting of implementation was found. One example of *duplication* was C2_Teacher 11 who commented on the WhatsApp VCoP about using material from the contact session in his teaching practice.

C2_Teacher 11: *Pacesetter vs Real Life is a very good tool. I use it to plan for all my grades. Thank you so much!*

An example of *duplication* in Cycle 3 was C3_Teacher14, who posted the photo of an osmosis investigation that was originally done during one of the TPL contact sessions. The photo was taken by the mentor during her mentoring visit. (Figure 6.18).

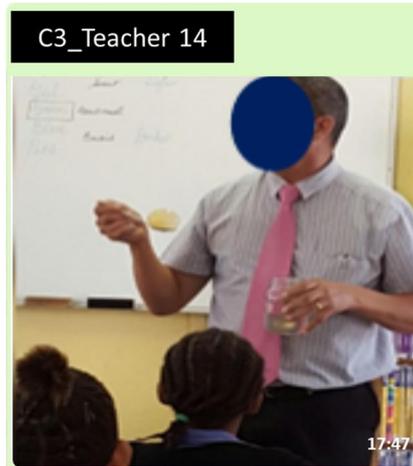


Figure 6.18: Screenshot of a post in Cycle 3, where a student is repeating an investigation from the TPL short course, as an example of the theme *duplication*.

The sub-theme *adaptation* refers to either the adaptation of the material or an adaptation in the use of the material during implementation. One of the main reasons for adapting material, linked to students' teaching context. Many students did not have access to technological resources in their schools. They therefore had to adapt material to be able to implement it. The examples shown in Figure 6.19 come from WhatsApp group posts. In Cycle 1 C1_Facilitator 02 had posted a photograph of how a participant had adapted an online activity, done during a TPL contact session, to a paper activity that could be used in her classroom context. In the online activity learners had to move examples of different types of energies to their correct headings. In the paper version learners were given paper posters and wrote the correct heading next to each energy statement (Figure 6.19).

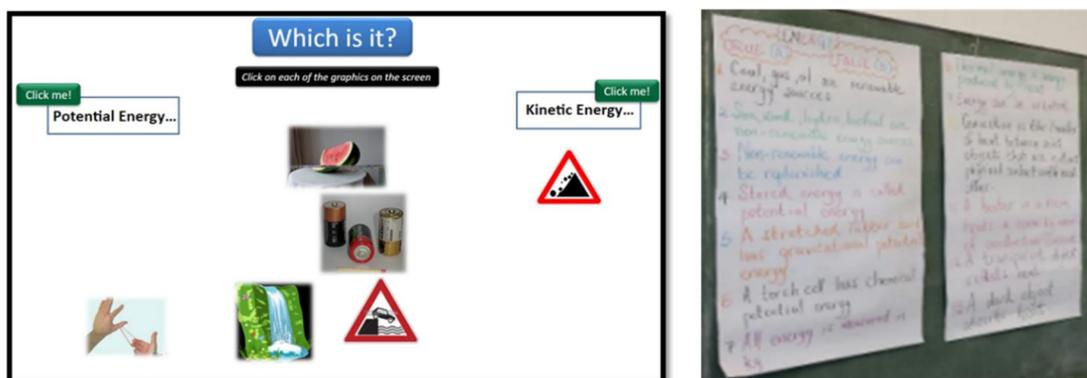


Figure 6.19: The original online activity (left) vs the student adapted paper activity (right).

Many video clips were posted by the researcher and other facilitators in Cycle 2. C2_Teacher 01 knew that her learners had cellular phones that they could use to download the video clips, but data costs were an issue. She solved the problem and posted about it on the VCoP.

C2_Teacher 01: *I gave them clips that we send with Share it and Bluetooth so that we can overcome the problem of them not having data.*

An example of the sub-theme *adaptation* in Cycle 3 was posted by the C3_Mentor during one of her mentoring visits. C3_Teacher 06 wanted to use an atom building simulation with her learners, but did not have any access to technology in her school. She used paper plates and different types of beans to recreate the simulation for her learners, and integrated it with a mathematical lesson on using a compass to draw circles (Figure 6.20).

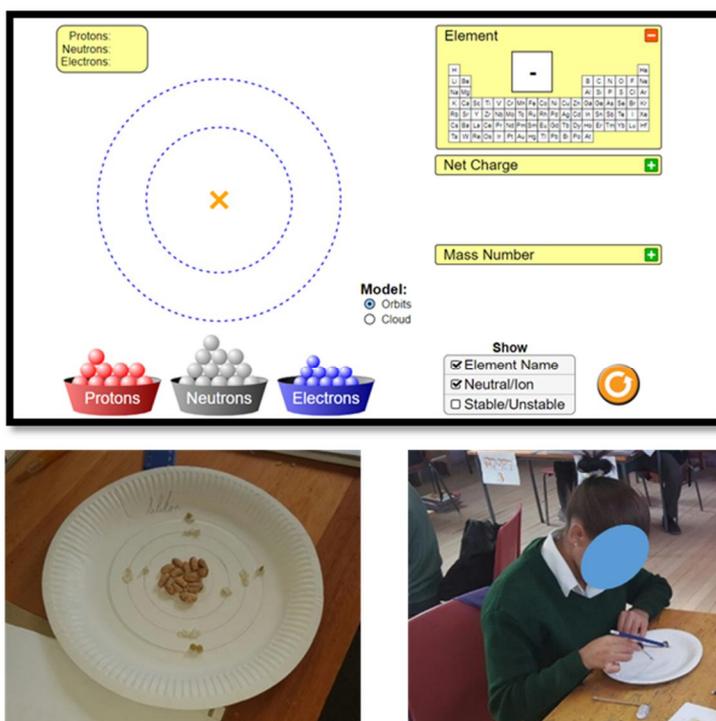


Figure 6.20: The original simulation (top) and photos from the adapted activity (bottom left and right).

Participants did not only lack technological resources, but since many of them were teaching in rural or farm schools, they sometimes even lacked basic teaching resources. In Cycle 1, C1_Teacher 07 wanted to use a formative assessment activity in which learners doing group work could hold up a red or a green card to indicate whether they understood an instruction or needed assistance (robot cards). The school could not supply her with red and green cards, so, when her son had a birthday party, she bought red and green paper flags to use as decoration. Afterwards she took them to school to use as robot cards (Figure 6:21).



Figure 6.21: Screenshot of a post in Cycle 1, where C1_Teacher 07 posted a photo of the flags she used when her school could not supply her with red and green cards. (Sub-theme: *adaptation*).

In Cycle 2 there were no examples of adaptation due to lack of teaching resources. C3_Teacher 04, in Cycle 3, wanted her learners to be actively involved in a sorting of materials activity. The TPL activity used different coloured beads in the hand sorting activity. C3_Teacher 04 did not have beads in her classroom, but she had fruit from her garden and rice from her kitchen. The facilitator/mentor took a photo of the activity and uploaded it to the VCoP (Figure 6.22).



Figure 6.22: Screenshot of a post in Cycle 3, where C3_Teacher 04 is using an adapted version of the hand sorting activity. (Sub-theme: *adaptation*).⁵⁹

A third type of adaptation was found where participants taught other subjects, besides the one targeted by the TPL short course; a rather common occurrence in South Africa. In Cycle 2 there was only one example of *adaptation* and it fell into this category. In the Life Sciences TPL contact session a song about the phases of mitosis was used to learn the names of the different phases. C2_Teacher 02 also teaches Natural Sciences, so he took this idea, had his grade 8 Natural Sciences learners write a song about the three states of matter, recorded them performing it and posted it in the VCoP (Figure 6.23).



Figure 6.23: Screenshot of a post in Cycle 2, where C2_Teacher 02 posted a video of his learners singing their three states of matter song. (Sub-theme: *adaptation*).

In Cycle 3, a Natural Sciences TPL short course, C3_Teacher 07 had done an activity on acids and bases. When teaching a Life Sciences lesson on the tongue and its taste

⁵⁹ Translation: Hand sorting, C3_Teacher 04 explaining to class what to do.

sensations, he incorporated this activity into his lesson. C3_Mentor took a photo of the activity and uploaded it to the VCoP (Figure 6.24).



Figure 6.24: Screenshot of a post in Cycle 3, where C3_Teacher 07 adapted a Natural Sciences activity for a Life Sciences lesson. (Sub-theme: *adaptation*).⁶⁰

Hayden, Rundell and Smyntek-Gworek (2013) refer to implementing course activities in an identical or similar manner as a novice response, as they argue that novice teaching lack the automative, adaptive responses of expert teaching. Adaptive expertise, or dynamic teaching as referred to by Shulman and Shulman (2004), has been found to be a critical factor in the support of "at risk" learners in under-resourced schools (Hayden et al., 2013; McNaughton, 2011). Adaptive expertise is also a desirable element of TSPCK (Schneider, 2015). All three cycles showed evidence of novice teaching responses, but more positively, all three VCoPs also showed evidence of participants displaying adaptive expertise.

Both main implementation support themes, *VCoP as support* and *VCoP as reporting platform*, featured in Cycle 1, the minimally structured VCoP that aligned with the heutagogical approach of self-determination. In Cycles 2 and 3 only the theme *VCoP as reporting platform* featured, as no requests for implementation support were made in either of these two cycles. Cycle 3 featured the most incidences of the VCoP acting as reporting platform for reports of implementation, due to the facilitator/mentor's initiative to post photos from her mentoring visits to each of the participants. It also featured the most incidences of adaptive expertise responses. A summary of implementation support themes in each VCoP can be seen in Table 6.8.

⁶⁰ Translation: Acids and bases in the Life Sciences classroom

Table 6.8:

A summary of the main and sub-themes, linked to implementation support in the TPL short course, found in each cycle.

Main themes	Sub-themes	Cycle 1	Cycle 2	Cycle 3
VCoP as support	Support to students on implementation issues	✓		
VCoP as reporting platform	Duplication	✓	✓	✓
	Adaptation			
	• Lack of technological resources	✓	✓	✓
	• Lack of general teaching resources	✓		✓
	• For use in other subjects		✓	✓

6.3.4.2 Design principles for VCoPs that provide implementation support to participants in a TPL short course

To answer sub-research question 5, the researcher needed to identify the ways in which each VCoP supported students to implement TPL short course content knowledge and skills in their teaching contexts. Only Cycle 1 participants requested support on implementation issues. This, however, does not mean that the other cycles could not offer such support. In Cycle 2 the VCoP only started at the end of the contact session and there were no mentors in this short course. This could have hampered participant implementation impetus. In Cycle 3 participants had requested support on implementation issues from the C3_Mentor in person. Design principle 12 would therefore be to ensure that implementation support is explicitly offered as an option to participants in a VCoP, thereby informing participants that the VCoP has that affordance. Design principle 13 is to have mentors that can physically visit participants in their classrooms in blended-learning TPL short courses where possible. It is also critical to ensure that these mentors are part of the VCoP and that they are aware of the reporting platform affordance of VCoPs. This requirement forms Design principle 14. By using the VCoP as reporting platform, the service provider can have a physical record of implementation on the VCoP and evaluate novice versus adapted response implementation. A summary of the three design principles, linked to sub-research question 5, that emerged from the framework analysis can be found in Table 6.9.

Table 6.9:

A summary of the three design principles of VCoPs that effectively support implementation in TPL short courses (sub-research question 5), that emerged from the thematic framework analysis.

Design principle #	Description of design principle
12	<ul style="list-style-type: none"> The service provider of the TPL short course should ensure that facilitators in the VCoP offer explicit implementation support to participants.
13	<ul style="list-style-type: none"> Whenever possible, a blended-learning TPL short course should have mentors that are part of the VCoP. They should do at least one class visit per participant, to report on implementation.
14	<ul style="list-style-type: none"> The service provider of the TPL short course should ensure that mentors in the VCoP are aware of its reporting platform affordance.

6.3.5 The ways in which each VCoP supported TPL short courses' impact on learner performance

Sub-research question 6 asked in which ways each WhatsApp VCoP impacted the learners taught by the TPL short course students. This sub-research question is informed by level 5 of Guskey's (2002) five levels of determining the effectiveness of professional development programmes: learner performance. Guskey (2002, p. 49) argues that learner impact is the "bottom line" or the most important reason for the existence of TPL short courses. If learners do not benefit from a TPL short course, Guskey (2002) judges the programme to be ineffective. In this study the impact on learners could mainly be assessed via feedback from the TPL participants, in other words on the level of perception of impact. Two *a priori* codes, linking to Guskey's (2002) descriptors of learner performance, were used to code the data: #access (demonstrations of learners participating in course activities in their classrooms) and #benefit (reports of learners benefitting from their teachers participating in the course VCoPs).

6.3.5.1 Themes linking to TPL short course impact on learners, emerging from the thematic framework analysis

From the thematic framework analysis, two main themes that are closely linked to the codes, emerged: (i) *learner access* and (ii) *learner benefit*. *Learner access* refers to reports or proof of learners accessing course material/activities. *Learner benefit* refers to reports of learners benefitting from their teachers attending the TPL short course.

Examples of the theme *learner access* were found in all three cycles. In Cycle 1, examples were found on the WhatsApp group and in the interviews. C1_Facilitator 02 posted a photo

of learners using thermometers in class during a mentoring class visit (Figure 6.25). This is a skill that was practiced during the TPL short course, and photos of the activity were posted on the group at the time.

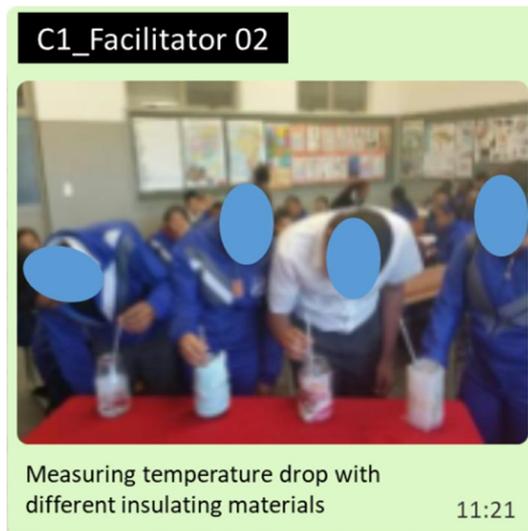


Figure 6.25: Screenshot of a post in Cycle 1, where learners of C1_Teacher 14 were using thermometers in their class (Theme: *learner access*).

In the interviews, C1_Teacher 06 referred to using the material posted on the group in class, and sharing it with his colleagues in neighbouring schools.

C1_Teacher 06: *Ek gebruik die materiaal in my klaskamer. Uhm...ek het uitgedeel aan my kollegas...so...nie net my kollegas by die skool nie, ook aan ander skole...my buurskole...het ek van hierdie inligting oorgedra. En...uhm...ek het nou net verlede week het ek gesels met een van die opvoeders hier by ons buurskool en sy sê sy gebruik van my materiaal wat ek oorgedra het aan haar.* [Translation: I use the material in my classroom. I shared it with my colleagues, not only with the colleagues at my school, but with those at my neighbouring schools. Just last week I spoke to one of the educators at our neighbour school and she said she was using the material that I shared with her.]

In Cycle 2, examples of *learner access* were also found on the WhatsApp group and in the interviews. C2_Teacher 01 commented, in the VCoP, that the exam question examples posted on the group gave her new material to use with her learners.

C2_Teacher 01:☺ *I gave the weekend's examples to the kids today in between. It is refreshing examples compared to the "holrug-gerydes⁶¹" in the text books and past papers.*

In the interviews C2_Teacher 02 commented on downloading the video clips from the links posted on the VCoP, and using it in his classroom:

⁶¹ Translation: over-used ones

C2_Teacher 02: *I did download the YouTube videos...and then used it in my class, to give them visual lessons. So there were lots of content...I managed to take some back to the classroom.*

In Cycle 3, examples of the theme *learner access* were found in the C3_Mentor posted photos and videos of the learners actively involved with activities from the TPL short course. There were therefore physical proof of learners accessing the material from the participants' classrooms, and not only participant reports. One example was a photo posted (Figure 6.26) that showed C3_Teacher 13 and his learners repeating an experiment that he had partaken in during the contact session, and of which photos were posted (Figure 6.12) to the group at the time.



Figure 6.26: Screenshot of C3_Teacher 13 repeating an experiment that he had been part of during the contact session, with his learners (Theme: *learner access*).

All Cycle 3 participants interviewed also reported that they had used the material and activities in their classes, for example:

C3_Teacher 01: *Ja...kyk die inligting wat gedeel was het ek toegepas in my klas.* [Translation: Yes, the information that was shared I applied in my class].

Most of the participants in all three cycles taught in rural areas, often in high-poverty communities. Loucks-Horsley, Stiles, Mundry and Hewson (2010) and Bransford, Darling-Hammond and LePage (2010) are examples of a host of researchers who argue that learners from high-poverty communities can only succeed in science and mathematics if they have access to curriculum aligned instructional material and activities. In all three cycles, participants gave their learners access to the curriculum aligned activities from both the TPL contact sessions and those posted in the VCoPs.

Examples of the theme *learner benefit* were also found in all three cycles. In Cycle 1 the theme was found in WhatsApp messages and in the interviews. During Cycle 1, C1_Teacher 09 did the physical experiment, and photos were posted on the group. After

the contact session, C1_Teacher 09 related via a post how having her learners do an electrolysis experiment in class, benefited one of her weaker learners. She also included a photo of the learner doing the experiment (Figure 6.17)

C1_Teacher 09: *Hallo, kollegas. 'n Kind wat nie so sterk is nie, het vanoggend so my hart gesteel met sy korrekte antwoord waar ons besig was met die elektrolise proses. Ekt hom sommer 'n stywe drukkie gegee.* [Translation: Hi Colleagues. A child who is not very strong, stole my heart this morning when he gave a correct answer while we were busy with the electrolysis process. I gave him a big hug]

During the interviews, C1_Teacher 06 reported that having the learners repeat the experiments done in the contact sessions and/or posted in the VCoPs, not only improved their results and increased their interest in science, but even improved discipline, as the learners took responsibility for their own work.

C1_Teacher 06: *En ja, beter resultate...weet jy die kinders neem meer verantwoordelik...is meer verantwoordelik. Belangstelling in wetenskap die het ook bietjie aangewakker. Ek wil my amper half verstout en sê die dissipline het ook bietjie verbeter (giggel). Regtig waar, hulle hou van hierdie eksperimente en...en ondersoek wat hulle moet doen. Want hulle het mos nou self, dis hulle verantwoordelikheid om dit te doen.* [Translation: And yes, better results, you know, learners take more responsibility, are more responsible. Interest in science is also awakened a bit. I even want to suggest that discipline has improved (giggle). Really, they like doing these experiments and investigations that they have to do. Because they now have to do it themselves, they have to take responsibility.]

In Cycle 2 the theme *learner benefit* was only present in the interviews. C2_Teacher 02, a novice teacher, attended the TPL short course in his second year of teaching. After the final exams he phoned the researcher to report on his results and this conversation was included as part of his interview data. He was very excited to report on how the VCoP had benefited him and his grade 12 (final year of school) learners.

C2_Teacher 02: *And it is getting better now, and I must say I can see in the results...uhm...with my grade 12s I managed to get 100%*

Researcher: YES!

C2_Teacher 02: *(Giggle) Thank you! When I was in my first year of teaching, I was...I just used content...notes...notes... notes...but after the course I am doing something good. The videos that you shared on the group...and the ones I downloaded....I have a very open relationship with my grade 12s and I told them so this is what I learned...and I just want to play it for you guys...and they understand more of the subject!*

In Cycle 3 the theme *learner benefit* was also only present in the interviews. C3_Teacher 01 mentioned how his learners showed increased interest in the subject after implementing his new knowledge and skills. C3_Teacher 13 commented on how learner questions were referred to the group when he could not answer them.

C3_Teacher 01: *ek kon sien my kinders...hoe meer...uh...jy ander benaderings gebruik hoe beter vir hulle ook, want...hulle soms raak so gewoon aan jou styl. Nou as jy nou ander dinge inbring wat jy leer, dan is dit nogal prikkelend...vir die kinders.* [Translation: I could see with my learners, the more I use different approaches, the better it is for them as they sometimes get used to your style. Now, when you bring in other things that you have learned, it is stimulating for the learners.

C3_Teacher 13: *Ek kon maklik hulle vrae wat ek self nou nie kon...kon antwoord nie...miskien. Hulle kom mos partykeer op 'n snaakse tyd met 'n vraag uit en dan het jy nie altyd dadelik 'n antwoord vir hulle nie...ek kon darem ten minste antwoorde op hul vrae kry deur middel van die groep.* [Translation: I could easily get answers to learner questions. They sometimes come with questions at weird times when you do not immediately have an answer for them. At least I could get answers to their questions via the group.]

Learner benefit from TPL short course implementation not only speaks to Guskey's (2002) view on TPL short course effectivity. It also resonates with Desimone's (2009) view that effective TPL short courses should change participant pedagogy, which she proposes will in turn enhance learners' learning. Learners benefitting from TPL short course implementation is also seen as a core feature of effective TPL short courses by Patton, Parker and Tannehill (2015). In all three cycles, examples or reports of learner access were found. In all three cycles reports from participants that their learners had benefitted from a VCoP enhanced TPL short course, were also found. This confirms that all three cycles were effective in supporting TPL short course impact on learner performance.

6.3.5.2 Design principles for VCoPs that support course impact on learner performance in a TPL short course

All three cycles were effective in supporting TPL short course impact on learner performance. Cycle 3, due to the class visits by the facilitator/mentor and her posting of proof of learner access and benefit, made it easier for the researcher to evaluate TPL short course impact on learners. This links to Design principle 13 (Table 6.9). No new design principles emerged from this section.

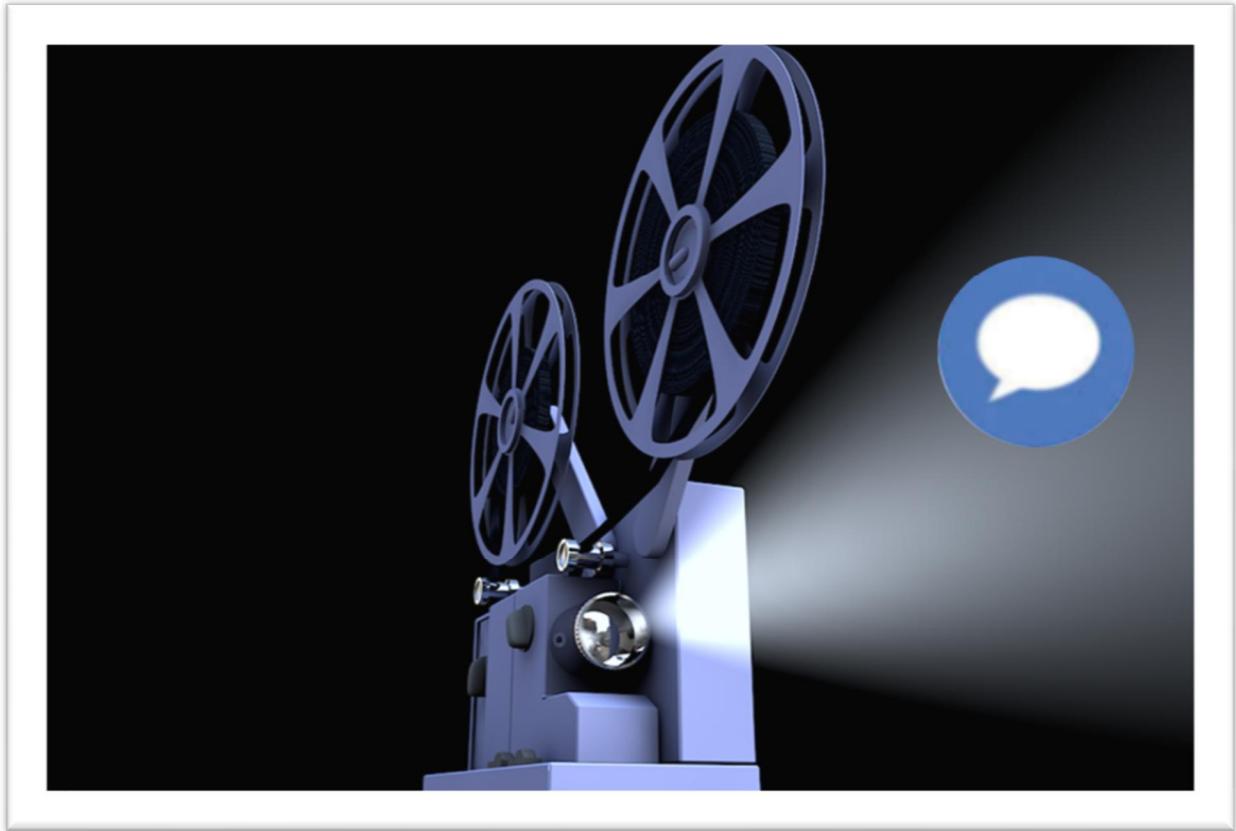
6.4 Chapter summary

In this chapter the qualitative data were analysed to determine how the different cycles supported professional development effectivity, as informed by Guskey's (2002) five levels of determining effectiveness. For Guskey's (2002) level 1, it was found that all three cycles supported initial satisfaction of teachers in the TPL short course. Themes that emerged linked to logistics, content choice, knowledgeability and language. Five design principles of VCoPs that support initial satisfaction with TPL short course effectivity, also emerged. All

three cycles supported teacher learning in the TPL short course, Guskey's (2002) level 2. Themes that emerged linked to inclusive learning, interactive learning and the VCoPs acting as learning repositories. Four design principles, linked to Guskey's (2002) level 2, emerged from the analysis. For Guskey's (2002) level 3, all three cycles provided organisational support and change characteristics, with the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, Cycle 2, providing the most support. Themes, linked to Guskey's (2002) level 3 descriptors, that emerged were encouragement of student learning, encouragement or support of student change at individual level, sharing of course relevant materials/activities, receiving adequate resources, student reflection, and recognition and sharing of student success. Four design principles of VCoPs that effectively provide organisational support and change in TPL short courses emerged from the analysis.

All three cycles supported implementation of TPL knowledge and skills. From the themes that emerged it was found that Cycles 2 and 3 only provided support to assess implementation, whereas the minimally structured VCoP that aligned with the heutagogical approach of self-determination, Cycle 1, also provided support to students with implementation issues. Two design principles of VCoPs that effectively support implementation in TPL short courses emerged from the analysis. For the final Guskey (2002) level, all three cycles effectively supported impact on learner performance. Learners accessed, and benefitted from, the material and activities posted in the VCoPs. No new design principles emerged from the analysis of this level. In total fourteen design principles emerged in the retrospective, summative analysis in this chapter.

In the next chapter, the chapter summaries, the main findings and design principles emerging from this study, are discussed. These are followed by the conclusions, limitations, recommendations and closing thoughts.



PRESENT

- **Discussion, conclusions, limitations and recommendations**

CHAPTER 7: PRESENTING A WHATSAPP VCoP MODEL TO SUPPORT THE EFFECTIVENESS OF BLENDED-LEARNING TPL SHORT COURSES

The worthwhile problems are the ones you can really solve or help solve, the ones you can really contribute something to.
(Feynman, 2005)

7.1 Introduction

This study emanated from the researcher perceiving gaps in knowledge about the use of WhatsApp groups as VCoP platforms to support Natural and Life Sciences blended-learning TPL short courses in South Africa. Two main gaps were perceived. Firstly, how such VCoPs could support the effectiveness of TPL short courses. Secondly, what design principles should inform the design of such VCoPs, to optimise support of the effectiveness of TPL short courses. These two gaps translated into the two main questions that guided the research:

- 1) The main research question: How can WhatsApp be optimally utilised to support the effectiveness of blended-learning formats of Natural and Life Sciences TPL short courses?
- 2) The main design question: Which design principles optimise support, via WhatsApp VCoPs, of the effectiveness of blended-learning formats of Natural and Life Sciences TPL short courses?

In this chapter, overviews are given of each of the preceding chapters. A summary of the findings of the study in answer to the two main questions, the limitations of the study and possible areas of future research, are then presented. Figure 7.1 provides a detailed outline of this chapter.

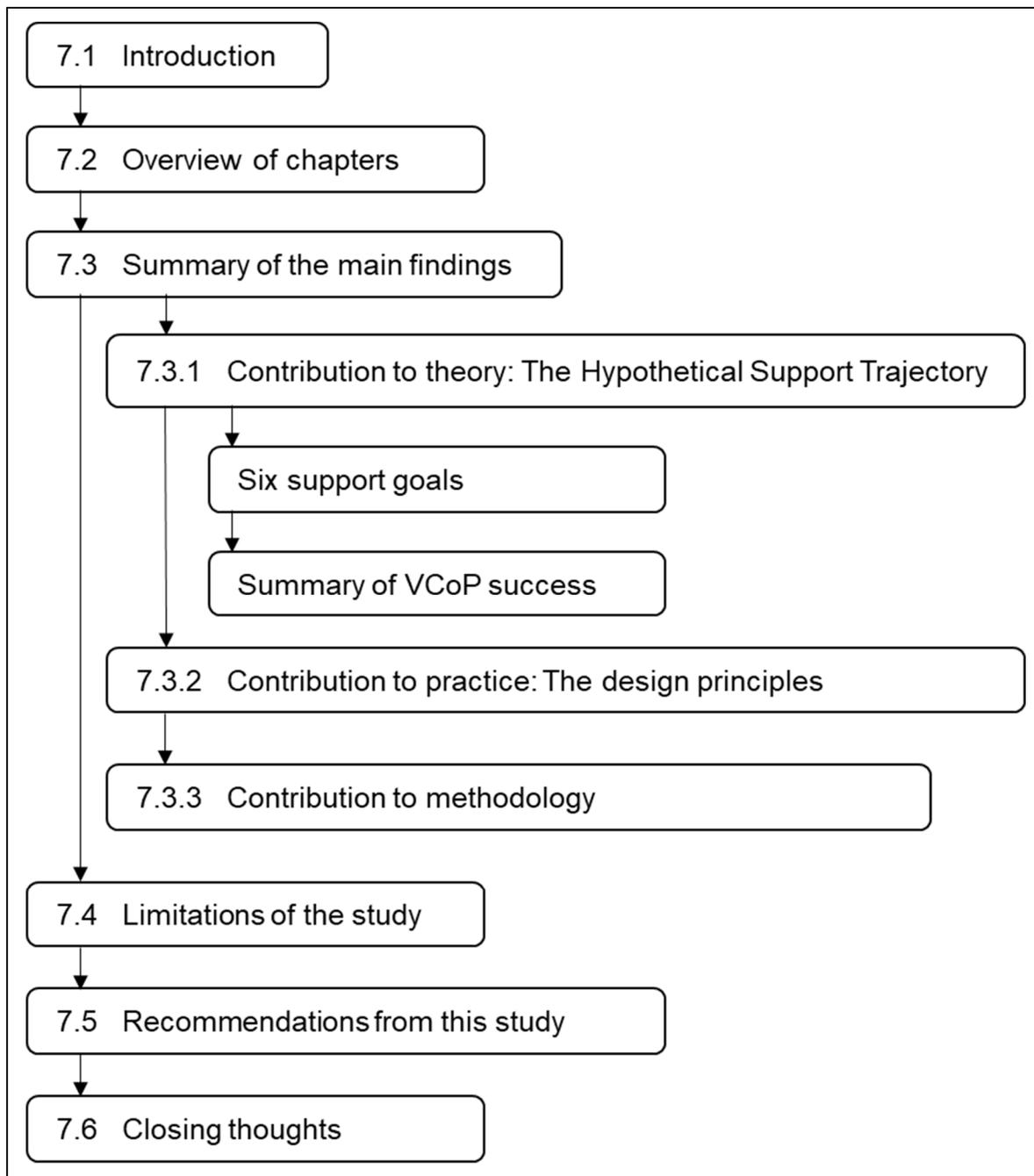


Figure 7.1: Chapter 7 outline.

7.2 Overview of chapters

Including this chapter, the dissertation comprises of seven chapters. The chapter divisions were based on the seven-step Easterday et al. (2017) DBR process. Step 1: FOCUS, as captured in Chapter 1, translated to the discussion of the background and motivation for the study. In Chapter 2, Step 2: UNDERSTAND, the researcher presented the literature that informed the study. Step 3: DEFINE and Step 4: CONCEIVE were combined in Chapter 3, where the theoretical and conceptual frameworks were portrayed. Step 5: BUILD, as presented in Chapter 4, translated to the description of the methodology and research design. Step 6: TEST, diverged into two presentation, analysis and interpretation chapters. Chapter 5 focussed on formatively evaluating each WhatsApp as valid VCoP (sub-research question 1), through the analysis of mainly quantitative data. Chapter 6 focussed on analysing the qualitative data to answer sub-research questions 2 to 6 that informed both the main research and main design questions. The current chapter is informed by Step 7: PRESENT. In the following sections a more detailed summary of each chapter is presented.

7.2.1 Chapter 1: Background and motivation

In Chapter 1 the background of, and motivation for, the study were outlined, providing focus for the study. The need for affordable VCoPs that provide dialogical synchronous and asynchronous academic support to TPL short course students across South Africa was highlighted. It was proposed that most South African teachers have access to, and are familiar with the use of smartphones and the affordable WhatsApp multimedia messaging application. As no congruence exists in the definitions of CoPs and PLCs, these terms, as well as the term VCoP, were introduced to the study. The context of TPL in South Africa, grounded in political history and changing policies, were then discussed, highlighting not only the necessity for TPL short courses, but also the need for professional teacher learning communities of practice to support these programmes. The need for guidelines or design principles to optimise the functioning of such CoPs, were also highlighted. This directly informed the next section of the chapter, namely the significance of the study. It was proposed that little is known about the design, implementation and successful formation of VCoPs within the South African TPL short course context and that this study aims to contribute to closing this knowledge gap. A formal statement of the problem, the main research and design questions, sub-questions and the objectives, in other words the elements that guided the study, were provided. This was followed by an introduction to DBR

as research design, the ethical considerations for this study, the delimitations and limitations, definitions of key terms and an overview of the chaptering.

7.2.2 Chapter 2: Perspectives from the literature

To show an understanding of the research problem, a literature review on topics that influenced this study's research process was presented in Chapter 2. A brief historical overview of the complexities of the South African teaching context, and teacher education and development, was provided. A discussion of the shifting landscape of policies and scope of Natural and Life Sciences teaching in South Africa followed. Both of these challenges highlighted the need for Natural and Life Sciences in-service TPL short courses. A review of teacher change models (Guskey, 2014; Pennington, 1995; Shalem, 2003) and life-long learning discourses (Kanwar & Balaji, 2017; Vig & Sharma, 2016) identified the need for organisational support of TPL short courses. A recent paradigm shift in the format of TPL short courses, from theory-laden, abstract TPD to practice-based TPL (Ball & Cohen, 1999; Knapp, 2003; Webster-Wright, 2009), was then addressed, leading into a discussion on the conceptual shift from general PCK to a focus on Veal and MaKinster's (1999) topic specific pedagogical content knowledge (TSPCK). TSPCK, as necessary component to develop the Nature of Science (NOS) in TPL short courses, was then highlighted (Rollnick & Davidowitz, 2015). This was followed by a discussion on the TPL presentation platform shift from face-2-face to ICT intensive environments. Included in the discussion was an unpacking of 21st century teaching skills. The difference between blended-learning and ICT integration (Anderson, 2010; Hanekom, 2017) was also defined. This discussion highlighted the need for TPL short courses that are ICT integrated and that model ICT integration to teachers.

7.2.3 Chapter 3: Weaving a theoretical framework to guide a conceptual design

One of the main arguments against the use of DBR comes from diSessa and Cobb (2004) who argue that most DBR studies are theoretically under-conceptualised. The researcher also noticed that DBR dissertations often do not include a theoretical framework or conceptual design. The conceptual design of this study, flowing from the theoretical framework that was weaved from four different theoretical threads, was therefore presented in Chapter 3. The first theoretical thread was Guskey's (2002) five levels of effective TPL short courses, as lens for the researcher to evaluate whether the model that is being designed would support TPL effectiveness. The second thread, social constructivism with

connectivist factors, formed the learning theory lens for the whole study. This thread highlighted the social situatedness of, and teachers' need for, practice-based interventions, informing the researcher about the support needs of teachers in TPL short courses. The third thread combined social and teaching presence and transactional distance theories, to frame the design of a model of TPL short course support that would specifically fit online environments. The final thread focussed on social media as boundary object and its perceived affordances, to theoretically motivate for the specific use of WhatsApp in the design of the support model.

7.2.4 Chapter 4: Research paradigm, methodology and research design

Chapter 4 discussed the research paradigm, methodology, research design, methods and instrumentation processes of the study. The choice of pragmatism as guiding paradigm for the study, was defended. This was followed by a demarcation of this study's methodology, arguments for and against DBR and a discussion of similarities with other methodologies. The use of DBR in higher degree research was also interrogated. A description of the general research design and process of a DBR study (that flowed into this study's DBR build step expansion) was presented. This included an overview of the iterative cycles and the design process. Within the design process, the new hypothetical support trajectory (HST) concept was presented, expanding into a discussion of the four design outcomes. The data collection instruments used, as well as a discussion on their reliability, validity and trustworthiness, were then presented, ending with a discussion of this study's data analysis approach.

7.2.5 Chapters 5 and 6: Presentation and analysis of results

Both these chapters communicated the data presentation and analysis of the data from the iterative cycles. Chapter 5 focussed on both the formative and retrospective, summative evaluations of VCoP effectiveness, through analysis of the mainly quantitative data from the VCoP validation questionnaire. Chapter 6 presented a qualitative retrospective, summative evaluation of each iterative cycle's VCoP to (i) determine their effectivity in supporting TPL short course effectiveness and (ii) determine design principles for future VCoPs. The main findings of these two chapters are discussed in the following section.

7.3 Summary of the main findings

The findings of this study are presented in two sections. The first section (7.3.1) links to the main research question. This section presents the newly proposed hypothetical support

trajectory (HST) concept, followed by a reflection on the sub-research questions, guided by the study's support goals. The second section (7.3.2) links to the main design question. The design principles found in answer to this main design question, are presented.

7.3.1 Contribution to theory: The Hypothetical Support Trajectory

The concept of a hypothetical learning trajectory (HLT), conceptualised by Simon (1995), has become a main component of most DBR studies. HLTs usually guide curriculum topic-specific studies (Bakker & Van Eerde, 2015). It did however not align with the broader academic support focus of this study. The researcher therefore coined the concept hypothetical support trajectory (HST) for this type of study. Instead of the HLT's three learning components, the HST comprises of three support components: (i) support goals, (ii) support activities and elements, and (iii) the hypothetical support process. The hypothetical support process is defined as a prediction of the main aim of the study, or more specifically for this study, as a prediction of the enhancement of professional development effectiveness. Each of this study's support goals linked to a sub-research question (SRQ), feeding into the main research question: **How can WhatsApp be optimally utilised to support the effectiveness of blended-learning formats of Natural and Life Sciences TPL short courses?**

The hypothetical support process for this study was described as the design of a VCoP, situated within a social media platform, that can create an environment that decreases transactional distance and that provides practice-based content that can support TPL students' course needs, thereby leading to enhanced TPL short course effectiveness. Three iterative cycles were designed, implemented and evaluated, both formatively and retrospective summatively. Cycle 1 was assigned a minimally structured WhatsApp group that aligned with the heutagogical approach of self-determination. The VCoP was created two weeks before the start of the short course's first contact session. Cycle 2 was assigned the facilitated structured WhatsApp group that aligned with the andragogical approach of self-directedness. The VCoP was created on the last day of the short course contact session. Informed by the formative evaluation of Cycles 1 and 2, the researcher added a third cycle (Cycle 3) and assigned to it a highly structured WhatsApp group that aligned with the pedagogical approach of lecture determination. The Cycle 3 VCoP was created a week before the start of the short course's first contact session. In the following sub-sections the

HST support goals will be used as guidelines to structure the presentation of the findings of this study.

7.3.1.1 Support goal 1: Creating a functioning VCoP

This goal linked to SRQ 1: **Which essential traits of a virtual community of practice (VCoP) were fostered in each WhatsApp VCoP?**

In Chapter 5 the analyses and interpretation of the VCoP validation instrument data during the formative evaluation stage, showed that all three cycles formed successful VCoPs. Support goal 1 and design outcome 1, the creation of a VCoP situated within a social media platform, were therefore deemed met in each cycle. From the first retrospective, summative evaluation, it was determined that Cycle 2, the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, was, according to student perception, most conducive in fostering the five Wenger (1998) essential traits of a VCoP. Cycle 1 placed second and Cycle 3 was least effective in supporting the Wenger (1998) essential traits of a VCoP. This concurred with Pittenger's (2013) finding that facilitated structured VCoPs best support learning through inter-professional collaboration.

To gain a more in-depth understanding, a second summative, retrospective evaluation of the quantitative data was carried out. In this evaluation the ranking of cycles, according to their effectiveness in fostering Murillo's (2008) sub-themes in each essential trait, was determined. Cycle 1, the minimally structured VCoP that aligned with the heutagogical approach of self-determination, was deemed most conducive in fostering Murillo's (2008) essential trait sub-themes. Cycle 2 placed second and Cycle 3 was found to be least effective in supporting Murillo's (2008) essential trait sub-themes. This finding concurs with Moore (1993; 2013) and Falloon (2011), who argue that increased dialogue, increased student autonomy and looser activity structure, lead to the lowest transactional distance, and therefore higher course satisfaction.

In the theoretical framework it was argued that learning in TPL short courses takes place at the intersection of the andragogic and heutagogic approaches. The two different outcomes in the summative, retrospective evaluations align with this argument, as the top ranking VCoP in the first summative, retrospective evaluation (Cycle 2) followed an andragogical approach, and the top ranking VCoP in the second (Cycle 1) a heutagogical approach. However, the essential trait sub-themes *improving professional skills in the VCoP* and

acquiring new knowledge in the VCoP are central to the academic and organisational support envisioned for this study, as they link to level 2, participant learning, and level 3, organisational support and change, of Guskey's (2002) five levels of determining the effectiveness of professional development programmes. Thus, despite placing last on a purely quantitative and participant perceptual view of essential trait and sub-theme effectiveness, participants perceived Cycle 3 to support their learning most effectively. In other words, participants perceived that the pedagogical approach to support their learning most effectively. The discussions of SRQ 3 (section 7.3.1.3) and SRQ 4 (section 7.3.1.4), which map to Guskey's (2002) level 2 and 3 respectively, triangulates with this finding.

7.3.1.2 Support goal 2: Supporting the initial satisfaction of teachers in the TPL courses

This goal linked to SRQ 2: **In which ways did each WhatsApp VCoP support the initial satisfaction of teachers in the TPL courses?**

SRQ 2 was informed by level 1 of Guskey's (2002) five levels of determining the effectiveness of professional development programmes: initial participant responses. The findings from the data showed that participants in all three cycles were generally satisfied with participation in the VCoPs [Theme: *general satisfaction (+)*]. Participants in all three cycles also showed satisfaction with what Kirschner et al. (2004) refer to as WhatsApp's technological affordance of synchronous communication [Theme: *communication between students (+)*]. Cycle 1 and 3 participants were satisfied with how logistics about the contact sessions were communicated in the VCoPs [Theme: *communication of logistics (+)*]. The Cycle 2 VCoP was only created at the end of the contact session and logistics were therefore not communicated on this group. In Cycles 2 and 3 there were participants who mentioned their satisfaction with being able to follow communications in the VCoP, without having to speak up themselves. These participants were classified as positive lurkers, aligning to Lee et al. (2006), Crawford (2009) and Rimé (2017) who perceive lurkers in online communities not as inactive members, but as active readers and learners. They also argue that such lurkers do not distract from the overall functioning of a community and should rather be called listeners [Theme: *positive lurking (+)*].

Whitworth, Gallupe and McQueen (2000) and Stahl, Koschmann and Suthers (2006) argue that off-topic, social conversations can be considered situated learning that can assist in establishing and maintaining group identity. In Cycle 1 though, a number of participants

expressed dissatisfaction with the amount of off-topic conversations [Theme: *off-topic conversations*]. Cycle 1 participants were allowed to post social content over weekends, but the researcher noticed the dissatisfaction during the cycle. Cycle 2 and 3 participants were therefore discouraged from posting any social content on the WhatsApp groups. Despite very few social posts in Cycle 3, one participant still voiced his/her⁶² dissatisfaction with off-topic conversations.

As for the initial satisfaction with the content posted on the WhatsApp groups, participants in all the cycles were satisfied with the general content [Theme: *general content (+)*] uploaded to the WhatsApp groups. They were also satisfied that the content aligned with the CAPS curriculum [Theme: *curriculum content (+)*]. In Cycle 2 a teachable moment presented itself, where some participants were dissatisfied with the content moving beyond the CAPS curriculum [Theme: *curriculum content (-)*]. Both the researcher and the provincial subject advisor advised the participants that teachers should always have a broader knowledge base than that of their learners. According to a plethora of literature, the quality of teachers determines the quality of teaching, and ultimately the performance of learners (Chetty, Friedman, & Rockoff, 2013; Borman & Kimball, 2005; Goldhaber et al., 2015; Ndlovu, 2011). Rivkin, Hanushek and Kain (2005) even found that the reduction of class sizes by an average of 10 learners had a smaller effect on learner performance than a one standard deviation in the quality of the teachers. Teachers therefore need to be life-long learners with a broader knowledge base than that of their learners.

The themes *general content (+)*, *curriculum content (+)* and *curriculum content (-)* speak to the notion of TSPCK as necessary component to develop the Nature of Science (NOS) in TPL short courses (Rollnick & Davidowitz, 2015). These themes also align with this study's design outcome 3, which aimed to support participants with practice-based content that enhances their TPL course needs. This design outcome is thus deemed met in all three cycles.

Another indicator of initial participant satisfaction is participant satisfaction with facilitator knowledgeability and helpfulness. Participants in all three cycles were generally satisfied with this indicator [Theme: *general knowledgeability (+)*]. Participants in Cycles 1 and 3

⁶² Due to total anonymity of the survey, the researcher could not determine the gender of the participant.

were also satisfied with the facilitators' methods and practice of teaching adults, in other words their andragogy [Theme: *andragogic knowledgeability (+)*]. Andragogy is deemed by Appova and Arbaugh (2017) to be one of the four main pillars that motivate adults to learn. The researcher could not determine Cycle 2's views on this theme, as they made no comments about it on the WhatsApp group, in the interviews or in the survey.

In South Africa language has always been a contentious issue in education (Cuvelier, Du Plessis, & Teck, 2003; Laufer, 2000; Olivier, 2009). Not only are there thirty-five languages indigenous to South Africa, of which 11 are official languages, but political influences have led to an educational system where very few teachers were taught in, or are now teaching in, their mother tongue (Cuvelier et al., 2003; Laufer, 2000). The language issue arose in the VCoP of Cycle 1. In this cycle participants taught in three different languages, Afrikaans, English and isiXhosa. English is only spoken as home language by 9.6%⁶³ of South Africans, but is used by most South Africans as the *lingua franca* in the work place and in government (Khokhlova, 2015). To ensure that all participants could participate on the group, the researcher chose English as common language. Before the contact session started, some participants were dissatisfied with this arrangement, but they were persuaded by the researcher and other members to accept this rule [Theme: *exclusive language use*]. Another example of exclusive language use was found when some participants, probably in haste, posted in their home languages (e.g. Afrikaans), leading to the other participants replying in their home languages (e.g. isiXhosa). For the most part though, participants would kindly remind the "wrongdoer" to use English or they would even translate the offending post to English [Theme: *inclusive language use*]. Although Cycle 2 participants spoke an even wider range of home languages, they either taught all their classes in English or taught at double medium schools where English was one of the languages of teaching. These participants did not have any issues with using English as common language on the VCoP. Cycle 3 participants were all Afrikaans home language speakers, and taught at Afrikaans schools in the rural areas of the Western Cape Province. Afrikaans was therefore the common language for this VCoP and no language issues arose.

⁶³ <http://www.statssa.gov.za> Census 2011

From the analysis of Cycle 1 responses, the study's presumption that WhatsApp is an affordable VCoP platform in the South African context, as argued by McKane (2018a, 2018b), was confirmed. Cycle 2 participants stayed and worked in the rural areas of the Northern Cape Province of South Africa. These participants also confirmed the study's presumption that WhatsApp can act as a boundary object, facilitating increased immediacy in these contexts, as argued by Gachago et al. (2015).

From these findings it was evident that all three WhatsApp VCoPs managed to support initial participant satisfaction, and they were therefore deemed to have met support goal 2. Five design principles arose from the themes discussed in this section. They are presented and elaborated on in section 7.3.2.

7.3.1.3 Support goal 3: Supporting teacher learning in the TPL short courses

This goal linked to SRQ 3: **In which ways did each WhatsApp VCoP support teacher learning in the TPL short courses?**

SRQ 3 was informed by level 2 of Guskey's (2002) five levels of determining the effectiveness of professional development programmes: participant learning. Three main themes emerged from the data: *inclusive learning* (all cycles), *interactive learning* (all cycles) and *learning repository* (Cycles 1 and 3). *Learning repository* referred to participants uploading conceptual content and examples of teaching methods or laboratory skills, during the course. Cycle 1 participants were found to have only used the VCoP as a *learning repository* during the contact sessions. Cycle 3 participants uploaded examples of teaching methods and laboratory skills during the contact sessions, as well as during their time back at their schools, between the contact sessions. As Cycle 2 was only created at the end of the contact session, participants could not upload examples during the contact session. They might not even have realised that they could use the group in such a manner after completing the contact session. Cycle 3 was therefore most effective in supporting teacher learning in the TPL short courses. Four design principles arose from the themes that were discussed in this section and one previous design principle was extended. The design principles are presented and elaborated on in section 7.3.2.

7.3.1.4 Support goal 4: Providing organisational support in the TPL short courses

This goal linked to SRQ 4: **In which ways did each WhatsApp VCoP provide organisational support in the TPL short courses?**

SRQ 4 was informed by level 3 of Guskey's (2002) five levels of determining the effectiveness of professional development programmes: organisational support and change. The SRQ was informed by two focus questions:

- (i) From the WhatsApp group messages: Was there evidence of SUNCEP providing organisational support and change characteristics, necessary for student success, in the VCoP?
- (ii) From the WhatsApp group messages, the interviews and the qualitative question in the survey: Did the participants in the WhatsApp groups perceive organisational support from SUNCEP?

Guskey (2002) poses six descriptors of organisational support and change, namely encouragement or support of student learning, encouragement or support of student change at individual level, students receiving sufficient resources, sharing of course relevant material/activities, reflecting on course material/activities or reflecting on implementation in the classroom, and recognition and sharing of student success. SUNCEP was able to provide support linked to four of the descriptors. Three of these descriptors were found in all three cycles: encouragement or support of student learning, sharing of course relevant material/activities, and recognition and sharing of student success. Cycle 2 was the only cycle that showed evidence of encouragement or support of student change at individual level. Students perceived organisational support from SUNCEP, linked to the following four descriptors, in all cycles: Encouragement or support of student learning, encouragement or support of student change at individual level, students receiving sufficient resources and lastly reflecting on course material/activities or on implementation in the classroom.

From the further analysis and interpretation of the data, eight organisational support and change characteristics, provided by SUNCEP, were found. *Supporting ICT skills development, authentic curriculum delivery, sharing of course relevant materials and activities, and recognition and sharing of student success* featured in all three cycles. In Cycle 2, *concept clarification, addressing topic misconceptions, learner assessment support, and encouragement or support of student change* also featured. In answer to the first focus question, Cycle 2, the cycle that was assigned the facilitated structured VCoP that aligned with the andragogical approach of self-directedness, provided more organisational support and change characteristics than the other cycles.

The findings from the data showed 11 organisational support and change characteristics perceived by students in the VCoPs. In all cycles, *general learning support*, *receiving enough resources* and *reflection on implementation in the classroom* were found. Both Cycles 2 and 3 featured student perception of *narrowing of transactional distance* and *creating a trusting environment*. However, in Cycle 3 there were also many instances of a lack of trust, where participants preferred to communicate with the mentor/facilitator rather than in the study's VCoP. Therefore, Cycle 2 is deemed to have met Design principle 2, an environment that decreases transactional distance, more effectively than Cycle 3. Cycles 1 and 2 featured student perception of *incorporating new knowledge in teaching*. Cycle 1 and 3 featured students reflecting on course material/activities. Two organisational and support characteristics perceived by participants in Cycle 1 did not feature in the other two cycles: *broadcast learning support* and *change in attitude and approach to teaching*. Cycle 3 was the only cycle where *reflection on assumptions about own teaching practice* featured.

From a quantitative view, Cycles 1 and 3 featured the same number of organisational support characteristics. Of the two cycles, from a qualitative view, Cycle 1 was perceived to most effectively support organisational support characteristics linked to the indicator encouragement or support of student change. Cycle 3 was however perceived to most effectively support organisational support characteristics linked to the indicator encouragement or support of student learning, and also the indicator reflecting on course material/activities or on implementation in the classroom. Reflection is a key component of both PCK and TSPCK (Rollnick & Davidowitz, 2015; Shulman, 1987) and support of student learning speaks to one of the study's objectives of academically supporting students. Therefore, in answer to the second focus question, although Cycle 2 provided more organisational support and change characteristics than the other cycles, participants perceived Cycle 3, the highly structured VCoP in which researcher resource input were concept and time aligned with the TPL course to support their academic needs, to be most effective. In other words, the participants preferred academic support through the pedagogical approach of lecture determination to support through either an andragogical approach of self-directedness or a heutagogical approach of self-determination. Four design principles arose from the themes that were discussed in this section and one previous design principle was extended. The design principles are presented and elaborated on in section 7.3.2.

7.3.1.5 Support goal 5: Supporting implementation of TPL short course knowledge and skills

This goal linked to SRQ 5: **In which ways did each WhatsApp VCoP support teachers to implement new knowledge and skills, gained during the TPL short courses, in classroom practice?**

SRQ 5 was informed by level 4 of Guskey's (2002) five levels of determining the effectiveness of professional development programmes: participants' use of new knowledge and skills. Guskey (2002) emphasises that this level cannot be evaluated during the contact session, but only after sufficient time has passed for participants to implement their learnings at their schools. Hence, only the interview data and WhatsApp message data that followed the contact sessions were analysed. The findings from the data showed two main themes: *VCoP as support of implementation* and *VCoP as reporting platform*. All the cycles performed as reporting platforms, as evidence of teachers implementing their new knowledge and skills was shown. In all the cycles, *duplication*, the use of material or activities in an identical or similar way, was evident. In all cycles, *adaptation* (the use of material or activities in adapted ways) was also present. The reasons for adaptation were found to be a lack of technological resources (all cycles), a lack of general teaching resources (Cycles 1 and 3) and to modify material for use in different subjects (Cycles 2 and 3). All the examples of adaptation for use in different subjects came from teachers who taught both Natural and Life Sciences, showing the linked nature of the two subjects focussed on in this study. Adaptive expertise, or dynamic teaching as referred to by Shulman and Shulman (2004), has been found to be a critical factor in the support of "at risk" learners in under-resourced schools (Hayden et al., 2013; McNaughton, 2011).

Only Cycle 1 showed evidence of a *VCoP as support of implementation*, as participants had requested, and were given, support for implementation. No such requests appeared in Cycles 2 and 3. Cycle 3 participants were supported in implementation by a course mentor/facilitator during her class visits. The participants in Cycle 3 therefore had no need to request support in the VCoP.

Three design principles arose from the themes discussed in this section. They are presented and elaborated on in section 7.3.2.

7.3.1.6 Support goal 6: Supporting TPL short course impact on learner performance

This goal linked to SRQ 6: **In which ways did each WhatsApp VCoP support TPL short course impact on learner performance?**

SRQ 6 was informed by level 5 of Guskey's (2002) five levels of determining the effectiveness of professional development programmes: learner performance. Learner impact is the most important reason for the existence of TPL courses (Guskey, 2002). If learners do not benefit from their teachers attending a TPL short course, Guskey (2002) judges the programme to be ineffective. In this study the impact on learners could mainly be assessed via feedback from the TPL participants, in other words on the level of perception of impact. Two main themes emerged from the data, *learner access* and *learner benefit*. *Learner access* refers to reports or proof of learners accessing course material/activities. *Learner benefit* refers to reports of learners benefitting from their teachers attending the TPL short course. In all three cycles examples or reports of learner access were found. Reports from participants that their learners had benefitted from a VCoP enhanced TPL short course, were also found in all three cycles. This confirms that all three cycles were effective in supporting TPL short course impact on learner performance.

No new design principles arose from the themes discussed in this section. However, a previous design principle was confirmed again.

7.3.1.7 A summary of VCoP success in supporting TPL course effectiveness in the three cycles

Through the hypothetical support process, the study aimed to design a VCoP support model situated within a social media platform (Design outcome 1), thereby creating an environment that decreases transactional distance (Design outcome 2), that provides practice-based content that supports TPL students' course needs (Design outcome 3), leading to enhanced TPL short course effectiveness (Design outcome 4). From the SRQ1 findings, all the WhatsApp groups functioned as valid VCoPs. Design outcome 1 was thus deemed met in all three cycles. Participants' perception of the *narrowing of transactional distance* featured only in Cycles 2 and 3. Design outcome 2 was consequently deemed met in Cycles 2 and 3. Cycle 2, due to issues of trust in Cycle 3, was however deemed to be most effective in terms of meeting this design outcome. All three cycles, both from the VCoP validation analysis and from the Guskey (2002) level evaluations, managed to support participants

with practice-based content that met their course needs. Design outcome 3 was hence deemed met in all three cycles. From the findings presented in support goals 2 to 6, all three cycles, in various ways, supported enhanced TPL short course effectiveness. Design outcome 4 was therefore deemed met in all cycles. From both the VCoP validation analysis and the Guskey (2002) level evaluations, Cycle 3 most effectively supported knowledge acquisition and the development of professional skills, elements central to academic support. Consequently, Cycle 3 was regarded to be the most effective in terms of this design outcome. In order to advise on the effective creation of future VCoPs, the findings from the study were converted to fourteen design principles.

7.3.2 Contribution to practice: The design principles

This study's main design question was: **Which design principles optimises support, via WhatsApp VCoPs, of the effectiveness of blended-learning formats of Natural and Life Sciences TPL short courses?**

VCoPs can potentially be an effective way to support participants in blended-learning formats of TPL short courses. At the start of the study it was mentioned that the ISPFTED (Department of Higher Education & Department of Basic Education, 2011) proposes that a set of guidelines should be developed to not only support the creation of, but also aid in the optimisation of, such communities. The fourteen design principles of WhatsApp VCoPs that effectively support blended-learning formats of Natural and Life Sciences TPL short courses, emerging from the analysis and interpretation of data in this study, can inform such a set of guidelines. These design principles, as recommended by Dede (2014), consider both the conditions for success, and the conditions that could lead to failure.

The principles were numbered in Chapter 6 according to the order in which they emerged, and not according to the categories that they were later divided into. The fourteen design principles were divided into three categories: principles relating to the creation of the structure of the VCoP, principles that guide the successful functioning of the VCoP and principles that could prevent failure of the VCoP. There are six design principles relating to the creation of the structure of the VCoP, design principles 1, 3, 7, 10, 11 and 13.

Design principle 1 advises on when the VCoP should be created. It is proposed that the WhatsApp group VCoP be created well ahead of the first contact session and that the participants should not already be part of separate VCoPs with facilitators on the short

course. This will ensure that the VCoP can be useful as a platform that can communicate logistics. It will also ensure that the participants can utilise the VCoP as learning repository during the contact sessions. Design principle 3 advises on the content posted to the VCoP by the TPL short course's service provider. The service provider needs to ensure that most content posted are curriculum related. Although it is desirable that some content go wider than the curriculum, it should still be aligned to the curriculum content. Design principles 7, 10 and 11 advise on the programme structure of the VCoP. Design principle 7 states that a facilitated structured VCoP aligned to the androgogical approach of self-directedness, most effectively (i) provides organisational support, (ii) supports problem solving in the VCoP and (iii) decreases transactional distance. Design principle 10 states that VCoPs do not intrinsically support encouragement, or support of learning or learner change, but that VCoPs have to be actively designed to include those characteristics. It was shown in the analysis that all three programme structures of the VCoPs tested supported (i) the sharing of course relevant material/activities, (ii) the perception of receiving sufficient resources, (iii) recognition of success and (iv) the sharing of student success. Design principle 11 therefore states that the programme structure of the VCoP has little influence on these four organisational support indicators. Design principle 13 advises on the required physical structure of the blended-learning TPL short course, if the use of a VCoP for academic and organisational support is to be implemented. Whenever possible, such a short course should have mentors that are part of the VCoP and they should be able to do at least one class visit per participant during the course, in order to report on implementation.

There are six design principles guiding the successful functioning of the VCoP, design principles 4, 6, 8, 9, 12 and 14. Design principles 4, 6, 8, 9 and 12 all advise on the roles of the course facilitators in the VCoP. The service provider of the TPL short course should ensure that facilitators in the VCoP have experience in supporting adult learners (Design principle 4), are familiar with the affordance of a WhatsApp VCoP to act as a summative assessment repository (Design principle 6) and can be utilised to increase interactivity for broadcasted lessons (Design principle 8). The service provider should also ensure that facilitators are aware that a WhatsApp VCoP can assist in creating more inclusive learning and assessment environments (Design principle 9) and offer explicit implementation support to participants (Design principle 12). Design principle 14 states that the service provider should ensure that the mentors are aware of the reporting platform affordance of a WhatsApp VCoP.

Finally, there are two design principles that could prevent failure of a VCoP. Design principle 2 states that off-topic conversations on the VCoP should be discouraged. Design principle 5 advises on language issues. The service provider should clearly communicate the VCoP's common language to participants when creating the VCoP. Facilitators on the group must also be extremely vigilant in noticing, and responding to, postings in languages other than the common language. Table 7.1. offers a summary of this study's 14 design principles.

Table 7.1:

A summary of the design principles of VCoPs that effectively support blended-learning short courses.

Category	Design principle #	Description of design principle
The structure of the VCoP	1	<ul style="list-style-type: none"> The VCoP should be created well ahead of the first contact session <ul style="list-style-type: none"> to be useful as a platform that communicates logistics to be useful as a learning repository for participants in a TPL short course Participants should also not be part of separate VCoPs with course facilitators.
	3	<ul style="list-style-type: none"> Ensure that most of the content posted is curriculum related.
	7	<ul style="list-style-type: none"> A facilitated structured VCoP, that aligns with the andragogical approach of self-directedness, most effectively: <ul style="list-style-type: none"> provides organisational support, supports problem solving in VCoPs, and narrows transactional distance.
	10	<ul style="list-style-type: none"> VCoPs do not intrinsically support encouragement, or support of learning or learner change, but VCoPs have to be actively designed to include those characteristics.
	11	<ul style="list-style-type: none"> The programme structure of the VCoP has little influence on the following four organisational support indicators: <ul style="list-style-type: none"> the sharing of course relevant material/activities, the perception of receiving sufficient resources, recognition of success and the sharing of student success.
	13	<ul style="list-style-type: none"> Whenever possible, a blended-learning TPL short course should have mentors that are part of the VCoP. They should do at least one class visit per participant, to report on implementation.
	Guiding successful functioning of the VCoP	4
6		<ul style="list-style-type: none"> The service provider of the TPL short course should ensure that facilitators in the VCoP are familiar with the affordance of a WhatsApp group to act as a summative assessment repository.
8		<ul style="list-style-type: none"> The service provider of the TPL short course should ensure that facilitators in the VCoP are aware that a WhatsApp group can be utilised to increase interactivity for broadcasted lessons.
9		<ul style="list-style-type: none"> The service provider of the TPL short course should ensure that facilitators in the VCoP are aware that it can create a more inclusive learning and assessment environment.
12		<ul style="list-style-type: none"> The service provider of the TPL short course should ensure that facilitators in the VCoP offer explicit implementation support to participants.
14		<ul style="list-style-type: none"> The service provider of the TPL short course should ensure that mentors in the VCoP are aware of its reporting platform affordance.
Preventing failure	2	<ul style="list-style-type: none"> Off-topic conversations in the VCoP should be discouraged.
	5	<ul style="list-style-type: none"> To avoid issues around language: <ul style="list-style-type: none"> clearly communicate the VCoP's common language to participants when creating the WhatsApp group facilitators on the group must be extremely vigilant in noticing, and responding to, postings in languages other than the common language.

7.3.3 Contribution to methodology

A main challenge facing doctoral students who decide on DBR as methodology for their study, is the alignment of the DBR process with the traditional dissertation chapter layout. The inability of students to find that alignment when attempting chaptering outside of the traditional layout, has led to arguments such as those of di Sessa and Cobb (2004). They contend that many DBR studies are theoretically under-conceptualised and that this lack of a proper conceptual framework negatively influences the generating of new theory. In this study the researcher found a solution for this challenge in the seven-step DBR process proposed by Easterday et al. (2017), as each of their steps could be aligned to the traditional dissertation chapter layout.

A second challenge within this study was to increase rigour and validity within the quantitative, formative evaluation chapter when working with limited group sizes. In DBR studies, the formative evaluation of data after each iterative cycle is usually followed by a single summative, retrospective analysis of all the data. In this study two summative, retrospective analyses were carried out, the first to determine rank order of VCoP effectivity to foster Wenger's (1998) five essential traits of CoPs and the second to determine rank order of VCoP effectivity to foster the essential trait sub-themes proposed by Murillo (2008). The sub-theme analysis complemented the original findings of the essential trait analysis, and therefore increased the rigour and validity of the results. The study therefore shows that analytical plurism can increase rigour and validity in DBR studies where the quantitative data sample sizes are small.

7.4 Limitations of the study

The timeframe, as well as external factors such as SUNCEP not offering Natural or Life Sciences short courses in 2016, only allowed the researcher to complete three iterative cycles for this study. Despite this, a rich data set was created, leading to 14 design principles and highlighting many ways in which a WhatsApp VCoP can be optimally utilised to support the effectiveness of blended-learning formats of Natural and Life Sciences TPL short courses. The timeframe prohibited the testing of a fourth cycle in which the design principles could be implemented and tested. This can be seen as a limitation. A further limitation was sample size. As mentioned in Chapter 1, funders determine the group sizes of SUNCEP TPL courses. The small sample sizes therefore had as consequence that the findings of the quantitative data analysis in Chapter 5 could be viewed as less conclusive, despite the

adapted methodology of analytic plurasm. Recommendations for further study would be, in line with the limitation mentioned, for a large-scale repeat of the study by well-resourced agencies such as the WCED or DBE.

7.5 Recommendations from this study

In the ISPFTED (Department of Higher Education & Department of Basic Education, 2011) it is proposed that a set of guidelines be developed to not only support the creation of CoPs, but also to aid in the optimisation thereof. The researcher therefore recommends that the design principles that emerged from this study be incorporated into SUNCEP, the WCED and DBE's TPL policies and guidelines on CoPs and VCoPs. It is also recommended that these design principles be implemented in all future VCoPs created within SUNCEP, the WCED and DBE's TPL short courses.

This study only focussed on Natural and Life Sciences short courses, with Natural Sciences being a baseline subject feeding into Life Sciences (a school exit subject). In South Africa Natural Sciences also serves as a baseline subject for Physical Sciences and Geography. It is therefore recommended that the design principles also be applied to, and evaluated in, short courses for these subjects.

7.6 Closing thoughts

The primary aim of this study flowed from the need of SUNCEP to academically support in-service teachers enrolled in blended-learning TPL short courses. This study has shown that WhatsApp groups can be effectively utilised as VCoPs for this purpose. It also presented design principles to assist other TPL course providers and policymakers in successfully creating and maintaining supportive WhatsApp VCoPs. The study therefore succeeded, through its Deweyan pragmatist research paradigm, to intertwine the nature of theory with the practice that is education.

I believe finally, that education must be conceived as a continuing reconstruction of experience; that the process and the goal of education are one and the same thing.

(Dewey, 1897)

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ADDENDA

ADDENDUM A: Ethics approval documents

ADDENDUM B: Copyright: Author permission letters

ADDENDUM C: The VCoP validation questionnaire

ADDENDUM D: The semi-structured interview schedule

ADDENDUM E: Example of a mapping matrix

ADDENDUM F: Doctoral study timeframe documentation

ADDENDUM A: Ethics approval documents

- Stellenbosch University approvals
- Provincial Education Department approvals
- Consent to participate in research: form examples

ADDENDUM A: Ethics approval documents Stellenbosch University

2015 - 2016



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Approved with Stipulations New Application

09-Sep-2015
Hanekom, Pauline PW

Proposal #: SU-HSD-000753

Title: Enhancing the effectiveness of in-service Natural Sciences teacher professional development by means of WhatsApp support.

Dear Ms. Pauline Hanekom,

Your **New Application** received on **02-Sep-2015**, was reviewed
Please note the following information about your approved research proposal:

Proposal Approval Period: **07-Sep-2015 -06-Sep-2016**

The following stipulations are relevant to the approval of your project and must be adhered to:
Please note that your project has been approved by the Research Ethics Committee: Humanities.

1) PARTICIPANT RECRUITMENT AND SELECTION

Under the section "ETHICAL CONSIDERATIONS" of the research proposal, the researcher states that informed consent will "be obtained from all participants: teachers and facilitators". In the section "DATA COLLECTION" of the research proposal, she also notes that surveys will be conducted among teachers, facilitators and curriculum advisors. The researcher is requested to confirm whether informed consent will also be obtained from the curriculum advisors.

2) TITLE OF THE PROJECT

The researcher's project title mentioned in the informed consent form differs from the title provided in the REC application form and the research proposal. The researcher is requested to clarify why she has indicated the title differently in the informed consent form.

Please provide a letter of response to all the points raised IN ADDITION to HIGHLIGHTING or using the TRACK CHANGES function to indicate ALL the corrections/amendments of ALL DOCUMENTS clearly in order to allow rapid scrutiny and appraisal.

Please take note of the general Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

Please remember to use your **proposal number** (SU-HSD-000753) on any documents or correspondence with the REC concerning your research proposal.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Also note that a progress report should be submitted to the Committee before the approval period has expired if a continuation is required. The Committee will then consider the continuation of the project for a further year (if necessary).

This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki and the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health). Annually a number of projects may be selected randomly for an external audit.

National Health Research Ethics Committee (NHREC) registration number REC-050411-032.

We wish you the best as you conduct your research.

If you have any questions or need further help, please contact the REC office at 218089183.

Included Documents:

REC: Humanities New Application

Sincerely,

Clarissa Graham
REC Coordinator
Research Ethics Committee: Human Research (Humanities)

Investigator Responsibilities

Protection of Human Research Participants

Some of the general responsibilities investigators have when conducting research involving human participants are listed below:

1. Conducting the Research. You are responsible for making sure that the research is conducted according to the REC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research. You must also ensure that the research is conducted within the standards of your field of research.

2. Participant Enrollment. You may not recruit or enroll participants prior to the REC approval date or after the expiration date of REC approval. All recruitment materials for any form of media must be approved by the REC prior to their use. If you need to recruit more participants than was noted in your REC approval letter, you must submit an amendment requesting an increase in the number of participants.

3. Informed Consent. You are responsible for obtaining and documenting effective informed consent using **only** the REC-approved consent documents, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least five (5) years.

4. Continuing Review. The REC must review and approve all REC-approved research proposals at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period**. Prior to the date on which the REC approval of the research expires, **it is your responsibility to submit the continuing review report in a timely fashion to ensure a lapse in REC approval does not occur**. If REC approval of your research lapses, you must stop new participant enrollment, and contact the REC office immediately.

5. Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, number of participants, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the REC for review using the current Amendment Form. You **may not initiate** any amendments or changes to your research without first obtaining written REC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.

6. Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research related injuries, occurring at this institution or at other performance sites must be reported to Malene Fouch within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the REC's requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch University Research Ethics Committee Standard Operating Procedures. All reportable events should be submitted to the REC using the Serious Adverse Event Report Form.

7. Research Record Keeping. You must keep the following research related records, at a minimum, in a secure location for a minimum of five years: the REC approved research proposal and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the REC

8. Provision of Counselling or emergency support. When a dedicated counsellor or psychologist provides support to a participant without prior REC review and approval, to the extent permitted by law, such activities will not be recognised as research nor the data used in support of research. Such cases should be indicated in the progress report or final report.

9. Final reports. When you have completed (no further participant enrollment, interactions, interventions or data analysis) or stopped work on your research, you must submit a Final Report to the REC.

10. On-Site Evaluations, Inspections, or Audits. If you are notified that your research will be reviewed or audited by the sponsor or any other external agency or any internal group, you must inform the REC immediately of the impending audit/evaluation.



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Approval Notice
Stipulated documents/requirements

15-Sep-2015
Hanekom, Pauline PW

Proposal #: SU-HSD-000753

Title: Enhancing the effectiveness of in-service Natural Sciences teacher professional development by means of WhatsApp support.

Dear Ms. Pauline Hanekom,

Your **Stipulated documents/requirements** received on **14-Sep-2015**, was reviewed
Sincerely,

Clarissa Graham
REC Coordinator
Research Ethics Committee: Human Research (Humanities)

Stellenbosch University

2017 – 2018



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Approval Notice Progress Report

08-Feb-2017
Hanekom, Pauline PW

Proposal#: SU-HSD-000753

Title: Enhancing the effectiveness of in-service Natural Sciences teacher professional development by means of WhatsApp support.

Dear Ms. Pauline Hanekom,

Your **Progress Report** received on **12-Jan-2017**, was reviewed by members of the **Research Ethics Committee: Human Research (Humanities)** via Expedited review procedures on **08-Feb-2017** and was approved.
Please note the following information about your approved research proposal:

Proposal Approval Period: **08-Feb-2017 -07-Feb-2018**

Please take note of the general Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

Please remember to use your **proposal number** (SU-HSD-000753) on any documents or correspondence with the REC concerning your research proposal.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Also note that a progress report should be submitted to the Committee before the approval period has expired if a continuation is required. The Committee will then consider the continuation of the project for a further year (if necessary).

This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki and the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health). Annually a number of projects may be selected randomly for an external audit.

National Health Research Ethics Committee (NHREC) registration number REC-050411-032.

We wish you the best as you conduct your research.

If you have any questions or need further help, please contact the REC office at 218089183.

Sincerely,

Clarissa Graham
REC Coordinator
Research Ethics Committee: Human Research (Humanities)

Investigator Responsibilities

Protection of Human Research Participants

Some of the general responsibilities investigators have when conducting research involving human participants are listed below:

1. Conducting the Research. You are responsible for making sure that the research is conducted according to the REC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research. You must also ensure that the research is conducted within the standards of your field of research.
2. Participant Enrollment. You may not recruit or enroll participants prior to the REC approval date or after the expiration date of REC approval. All recruitment materials for any form of media must be approved by the REC prior to their use. If you need to recruit more participants than was noted in your REC approval letter, you must submit an amendment requesting an increase in the number of participants.
3. Informed Consent. You are responsible for obtaining and documenting effective informed consent using **only** the REC-approved consent documents, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least five (5) years.
4. Continuing Review. The REC must review and approve all REC-approved research proposals at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period**. Prior to the date on which the REC approval of the research expires, **it is your responsibility to submit the continuing review report in a timely fashion to ensure a lapse in REC approval does not occur**. If REC approval of your research lapses, you must stop new participant enrollment, and contact the REC office immediately.
5. Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, number of participants, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the REC for review using the current Amendment Form. You **may not initiate** any amendments or changes to your research without first obtaining written REC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.
6. Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research related injuries, occurring at this institution or at other performance sites must be reported to Malene Fouch within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the RECs requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch University Research Ethics Committee Standard Operating Procedures. All reportable events should be submitted to the REC using the Serious Adverse Event Report Form.
7. Research Record Keeping. You must keep the following research related records, at a minimum, in a secure location for a minimum of five years: the REC approved research proposal and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the REC
8. Provision of Counselling or emergency support. When a dedicated counsellor or psychologist provides support to a participant without prior REC review and approval, to the extent permitted by law, such activities will not be recognised as research nor the data used in support of research. Such cases should be indicated in the progress report or final report.
9. Final reports. When you have completed (no further participant enrollment, interactions, interventions or data analysis) or stopped work on your research, you must submit a Final Report to the REC.
10. On-Site Evaluations, Inspections, or Audits. If you are notified that your research will be reviewed or audited by the sponsor or any other external agency or any internal group, you must inform the REC immediately of the impending audit/evaluation.

Stellenbosch University

2019: Title amendment

**NOTICE OF APPROVAL**

REC Humanities Amendment Form

18 March 2019

Project number: 4508

Project Title: Enhancing the effectiveness of in-service Natural Sciences teacher professional development by means of WhatsApp support.

Amended Project Title: Designing a WhatsApp vCoP model to support the effectiveness of blended-learning Teacher Professional Learning sciences short courses

Dear Ms. Pauline Hanekom

Your REC Humanities Amendment Form submitted on 7 February 2019 was reviewed and approved by the REC: Humanities.

Please note the following for your approved submission:

Ethics approval period:

Protocol approval date (Humanities)	Protocol expiration date (Humanities)
8 February 2017	7 February 2018

GENERAL COMMENTS:

The researcher is reminded to submit a final or progress report considering that the project approval expired on 7 February 2018.

Please take note of the General Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

If the researcher deviates in any way from the proposal approved by the REC: Humanities, the researcher must notify the REC of these changes.

Please use your SU project number (4508) on any documents or correspondence with the REC concerning your project.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

FOR CONTINUATION OF PROJECTS AFTER REC APPROVAL PERIOD

Please note that a progress report should be submitted to the Research Ethics Committee: Humanities before the approval period has expired if a continuation of ethics approval is required. The Committee will then consider the continuation of the project for a further year (if necessary)

Included Documents:

Document Type	File Name	Date	Version
Default	SU Consent to Participate in Research 2019_PWH	07/02/2019	1
Research Protocol/Proposal	PWHHanekom_11065095_Uncited_Chapter 1_20190207_Title amendment	07/02/2019	1

If you have any questions or need further help, please contact the REC office at cgraham@sun.ac.za.

Sincerely,

Clarissa Graham

REC Coordinator: Research Ethics Committee: Human Research (Humanities)

National Health Research Ethics Committee (NHREC) registration number: REC-050411-032.

The Research Ethics Committee: Humanities complies with the SA National Health Act No.61 2003 as it pertains to health research. In addition, this committee abides by the ethical norms and principles for research established by the Declaration of Helsinki (2013) and the Department of Health Guidelines for Ethical Research: Principles Structures and Processes (2nd Ed.) 2015. Annually a number of projects may be selected randomly for an external audit.

Investigator Responsibilities

Protection of Human Research Participants

Some of the general responsibilities investigators have when conducting research involving human participants are listed below:

1. Conducting the Research. You are responsible for making sure that the research is conducted according to the REC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research. You must also ensure that the research is conducted within the standards of your field of research.

2. Participant Enrollment. You may not recruit or enroll participants prior to the REC approval date or after the expiration date of REC approval. All recruitment materials for any form of media must be approved by the REC prior to their use.

3. Informed Consent. You are responsible for obtaining and documenting effective informed consent using **only** the REC-approved consent documents/process, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least five (5) years.

4. Continuing Review. The REC must review and approve all REC-approved research proposals at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period**. Prior to the date on which the REC approval of the research expires, **it is your responsibility to submit the progress report in a timely fashion to ensure a lapse in REC approval does not occur**. If REC approval of your research lapses, you must stop new participant enrollment, and contact the REC office immediately.

5. Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the REC for review using the current Amendment Form. You **may not initiate** any amendments or changes to your research without first obtaining written REC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.

6. Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research related injuries, occurring at this institution or at other performance sites must be reported to Malene Fouche within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the RECs requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch University Research Ethics Committee Standard Operating Procedures. All reportable events should be submitted to the REC using the Serious Adverse Event Report Form.

7. Research Record Keeping. You must keep the following research related records, at a minimum, in a secure location for a minimum of five years: the REC approved research proposal and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the REC

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9. Final reports. When you have completed (no further participant enrollment, interactions or interventions) or stopped work on your research, you must submit a Final Report to the REC.

10. On-Site Evaluations, Inspections, or Audits. If you are notified that your research will be reviewed or audited by the sponsor or any other external agency or any internal group, you must inform the REC immediately of the impending audit/evaluation.

Stellenbosch University

2019-2020

**NOTICE OF APPROVAL**

REC: SBER - Annual Progress/ Final Report

23 April 2019

Project number: 4508

Project Title: Enhancing the effectiveness of in-service Natural Sciences teacher professional development by means of WhatsApp support.

Dear Ms. Pauline Harekom

Your REC: SBER - Annual Progress/ Final Report submitted on 10 April 2019 was reviewed and approved by the REC: Humanities.

Please note the following for your approved submission:

Ethics approval period:

Protocol approval date (Humanities)	Protocol expiration date (Humanities)
23 April 2019	23 April 2020

GENERAL COMMENTS:

The REC finds the progress report in order. Extension of clearance granted to collect outstanding data under the same conditions as for the initially approved study.

Please take note of the General Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

If the researcher deviates in any way from the proposal approved by the REC: Humanities, the researcher must notify the REC of these changes.

Please use your SU project number (4508) on any documents or correspondence with the REC concerning your project.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

FOR CONTINUATION OF PROJECTS AFTER REC APPROVAL PERIOD

Please note that a progress report should be submitted to the Research Ethics Committee: Humanities before the approval period has expired if a continuation of ethics approval is required. The Committee will then consider the continuation of the project for a further year (if necessary)

Included Documents:

Document Type	File Name	Date	Version
Default	NC_Permission WhatsApp letter_2017	04/02/2019	1
Default	Research approval letter_WCED_2017-2018	04/02/2019	1
Default	2019_Institutional Permission Request Proposal#_SU-HSD-000753	04/02/2019	1
Informed Consent Form	SU_Consent_to_Participate_in_Research_2017_PWH	07/02/2019	1
Informed Consent Form	SU_Consent_to_Participate_in_Research_2019_PWH	07/02/2019	1
Research Protocol/Proposal	PWHharekom_11065095_Updated_Chapter 1_20190207	07/02/2019	1

If you have any questions or need further help, please contact the REC office at cgraham@sun.ac.za.

Sincerely,

Clarissa Graham

REC Coordinator: Research Ethics Committee: Human Research (Humanities)

National Health Research Ethics Committee (NHREC) registration number: REC-050411-032.

The Research Ethics Committee: Humanities complies with the SA National Health Act No.61 2003 as it pertains to health research. In addition, this committee abides by the ethical norms and principles for research established by the Declaration of Helsinki (2013) and the Department of Health Guidelines for Ethical Research: Principles Structures and Processes (2nd Ed.) 2015. Annually a number of projects may be selected randomly for an external audit.

Investigator Responsibilities

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4. Continuing Review. The REC must review and approve all REC-approved research proposals at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period**. Prior to the date on which the REC approval of the research expires, **it is your responsibility to submit the progress report in a timely fashion to ensure a lapse in REC approval does not occur**. If REC approval of your research lapses, you must stop new participant enrollment, and contact the REC office immediately.

5. Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the REC for review using the current Amendment Form. You **may not initiate** any amendments or changes to your research without first obtaining written REC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.

6. Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research related injuries, occurring at this institution or at other performance sites must be reported to Malene Fouche within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the RECs requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch University Research Ethics Committee Standard Operating Procedures. All reportable events should be submitted to the REC using the Serious Adverse Event Report Form.

7. Research Record Keeping. You must keep the following research related records, at a minimum, in a secure location for a minimum of five years: the REC approved research proposal and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the REC

8. Provision of Counselling or emergency support. When a dedicated counsellor or psychologist provides support to a participant without prior REC review and approval, to the extent permitted by law, such activities will not be recognised as research nor the data used in support of research. Such cases should be indicated in the progress report or final report.

9. Final reports. When you have completed (no further participant enrollment, interactions or interventions) or stopped work on your research, you must submit a Final Report to the REC.

10. On-Site Evaluations, Inspections, or Audits. If you are notified that your research will be reviewed or audited by the sponsor or any other external agency or any internal group, you must inform the REC immediately of the impending audit/evaluation.

Western Cape Education Department

2015-2016



Directorate: Research

Audrey.wynngaard@westerncape.gov.za
tel: +27 021 467 9272
Fax: 0865902282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20150713-1178

ENQUIRIES: Dr A T Wyngaard

Mrs Pauline Hanekom
Centre for Pedagogy
Stellenbosch University
Private Bag X1
Matieland
7602

Dear Mrs Pauline Hanekom

RESEARCH PROPOSAL: ENHANCING THE EFFECTIVENESS OF IN-SERVICE SENIOR PHASE NATURAL SCIENCES TEACHER PROFESSIONAL DEVELOPMENT BY MEANS OF WHATSAPP SUPPORT

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **01 August 2015 till 30 September 2016**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

**The Director: Research Services
Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000**

We wish you success in your research.

Kind regards.

Signed: Dr Audrey T Wyngaard

Directorate: Research

DATE: 14 July 2015

Lower Parliament Street, Cape Town, 8001
tel: +27 21 467 9272 fax: 0865902282
Safe Schools: 0800 45 46 47

Private Bag X9114, Cape Town, 8000
Employment and salary enquiries: 0861 92 33 22
www.westerncape.gov.za

Western Cape Education Department

2017 -2018



Directorate: Research

Audrey.wynngaard@westerncape.gov.za

tel: +27 021 467 9272

Fax: 0865902282

Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20150713-1178

ENQUIRIES: Dr A T Wynngaard

Mrs Pauline Hanekom
Centre for Pedagogy
Stellenbosch University
Private Bag X1
Matieland
7602

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1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **01 August 2015 till 30 September 2018**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wynngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

**The Director: Research Services
Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000**

We wish you success in your research.

Kind regards.

Signed: Dr Audrey T Wynngaard

Directorate: Research

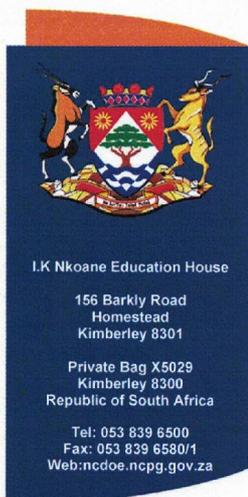
DATE: 21 April 2017

Lower Parliament Street, Cape Town, 8001
tel: +27 21 467 9272 fax: 0865902282
Safe Schools: 0800 45 46 47

Private Bag X9114, Cape Town, 8000
Employment and salary enquiries: 0861 92 33 22
www.westerncape.gov.za

Northern Cape Education Department

2017-2018



DEPARTMENT OF EDUCATION

Enquiries: - HC Burrows
Contact No: - 053-839 6701
Reference: -
Date: - 30 January 2017

To: Ms PW Hanekom

Subject: **Permission granted to conduct survey: How “WhatsApp” support can enhance the effectiveness of in-service Sciences teacher professional development.**

You are herewith granted permission to do the necessary research as per your request dated 23 January 2017.

The Northern Cape Department of Education however requests that the findings and recommendations be shared with the Curriculum Chief Directorate.

Yours sincerely

DR M ISHMAIL
DEPUTY DIRECTOR-GENERAL: CURRICULUM, EXAMINATIONS AND ASSESSMENT



Consent form Template: 2015-2016: Cycle 1



UNIVERSITEIT • STELLENBOSCH • UNIVERSITY
jou kennisvenoot • your knowledge partner

STELLENBOSCH UNIVERSITY CONSENT TO PARTICIPATE IN RESEARCH

Enhancing the effectiveness of in-service Senior Phase Natural Sciences teacher professional development by means of WhatsApp support.

You are asked to participate in a research study conducted by Mrs Pauline Wilna Hanekom, from the Stellenbosch University Centre for Pedagogy. The results will contribute to a PhD thesis and research papers. You were selected as a possible participant in this study because you are part of SUNCEP's in-service teacher training programmes.

1. PURPOSE OF THE STUDY

During the study the investigator will attempt to design a model to enhance the on-site implementation and adaptation of knowledge and skills, gained by teachers during in-service teacher training, through the use of social media, e.g. WhatsApp-groups, as supporting tools.

2. PROCEDURES

If you volunteer to participate in this study, we would ask you to do the following things:

- Join the WhatsApp groups when requested.
- Complete surveys on your usage of these tools.
- Be prepared to be interviewed one-on-one about the use of these tools.

You will be expected to use these tools for at least the length of your complete training programme (one short course / module).

Interviews will be completed during contact sessions, via electronic media such as WhatsApp, Google Hangouts or via e-mail as last resort.

Surveys will be posted through the SURvey software of Stellenbosch University.

3. POTENTIAL RISKS AND DISCOMFORTS

The only possible inconvenience might be amount of WhatsApp messages sent by participants, although there is the possibility to hide the messaging service for periods of time. No potential risks or discomforts are foreseen. Participants may mute their WhatsApp groups outside of normal working hours.

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

Possible benefits of participation in this research are increased Web 2.0 skills and easy access to assistance with both your training course and on-site teaching from both lecturers, mentors and fellow teachers.

5. PAYMENT FOR PARTICIPATION

NONE

6. CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of pseudonyms for all teacher names, schools and towns. Any images or video material posted on the WhatsApp group will be anonymized (blurring of faces and recognizable features such as school badges) if used in the dissertation or resulting papers.

Interviews will be recorded and transcribed. Participants have the right to review the transcriptions and request that certain parts not be used. After completion of the research these could be used for educational purposes, but anonymity will at all times be ensured.

7. PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so.

8. IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact Mrs Pauline Hanekom, Dr Mdu Ndlovu or Dr Sonja Strydom.

Mrs Pauline Hanekom:



Dr Mdu Ndlovu:



Dr Sonja Strydom:



9. RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

The information above was described to _____ (*the participant*) by _____ in _____ [*Afrikaans/English/Xhosa/other*] and I am in command of this language or it was satisfactorily translated to me. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

I hereby consent voluntarily to participate in this study. I have been given a copy of this form.

Name of Subject/Participant

Name of Legal Representative (if applicable)

Signature of Subject/Participant or Legal Representative

Date

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to _____ [*name of the subject/participant*]. [*He/she*] was encouraged and given ample time to ask me any questions. This conversation was conducted in [*Afrikaans/*English*] and no translator was used.

Signature of Investigator

Date

Consent form Template: 2017-2018: Cycle 2

6. CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be discussed only with your permission or as required by law. Confidentiality will be maintained by means of pseudonyms for all teacher names, schools and towns. Any images or video material posted on the WhatsApp group will be anonymized (blurring of faces and recognizable features such as school badges) if used in the dissertation or resulting papers.

Interviews will be recorded and transcribed. Participants have the right to review the transcripts and request that certain parts not be used. After completion of the research these could be used for educational purposes, but anonymity will at all times be ensured.

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8. IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact Mrs Pauline Hanekom, Dr Mdu Ndlovu or Dr Sonja Strydom.

Mrs Pauline Hanekom:

078 [REDACTED]
pwh

Dr Mdu Ndlovu:

021 [REDACTED]
mdu

Dr Sonja Strydom:

5011 [REDACTED]

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You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms Maléne Fouché [mfouch@sun.ac.za; 021 808 4622] at the Division for Research Development.



UNIVERSITY OF
STELLENBOSCH

STELLENBOSCH UNIVERSITY CONSENT TO PARTICIPATE IN RESEARCH

Enhancing the effectiveness of in-service Natural and Life Sciences teacher professional development by means of WhatsApp support.

You are asked to participate in a research study conducted by Mrs Pauline Wilma Hanekom, from the Stellenbosch University Centre for Pedagogy. The results will contribute to a PhD thesis and research papers. You were selected as a possible participant in this study because you are part of SUNCEP's in-service teacher training programmes.

1. PURPOSE OF THE STUDY

During the study the investigator will attempt to design a model to enhance the on-site implementation and adaptation of knowledge and skills, gained by teachers during in-service teacher training, through the use of social media, e.g. WhatsApp-groups, as supporting tools.

2. PROCEDURES

If you volunteer to participate in this study, we would ask you to do the following things:

- Join the WhatsApp groups when requested.
- Complete surveys on your usage of these tools.
- Be prepared to be interviewed one-on-one about the use of these tools.

You will be expected to use these tools for at least the length of your complete training programme (one short course / module).

Interviews will be completed during contact sessions, via electronic media such as WhatsApp, Google Hangouts, Adobe connect or via e-mail as last resort. Surveys will be posted on-line through the Survey software of Stellenbosch University.

3. POTENTIAL RISKS AND DISCOMFORTS

The only possible inconvenience might be amount of WhatsApp messages sent by participants, although there is the possibility to hide the messaging service for periods of time. No potential risks or discomforts are foreseen. Participants may mute their WhatsApp groups outside of normal working hours.

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

Possible benefits of participation in this research are increased Web 2.0 skills and easy access to assistance with both your training course and on-site teaching from both lecturers, mentors and fellow teachers.

5. PAYMENT FOR PARTICIPATION

NONE

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

The information above was described to _____ (*the participant*) by _____ in _____ [*Afrikaans/English/Xhosa/other*] and I am in command of this language or it was satisfactorily translated to me. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

I hereby consent voluntarily to participate in this study. I have been given a copy of this form.

Name of Subject/Participant

Name of Legal Representative (if applicable)

Signature of Subject/Participant or Legal Representative

Date

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to _____ [*name of the subject/participant*]. [*He/she*] was encouraged and given ample time to ask me any questions. This conversation was conducted in [*Afrikaans/*English*] and no translator was used.

Signature of Investigator

Date

Consent form Template: 2017-2018: Cycle 3

Group 3: Example



UNIVERSITEIT-STELLENBOSCH-UNIVERSITY
021 808 46223

**STELLENBOSCH UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH**

Enhancing the effectiveness of in-service Natural and Life Sciences teacher professional development by means of WhatsApp support.

You are asked to participate in a research study conducted by Mrs Pauline Wina Hanekom, from the Stellenbosch University Centre for Pedagogy. The results will contribute to a PhD thesis and research papers. You were selected as a possible participant in this study because you are part of SUNCEP's in-service teacher training programmes.

1. PURPOSE OF THE STUDY

During the study the investigator will attempt to design a model to enhance the on-site implementation and adaptation of knowledge and skills gained by means of during in-service teacher training, through the use of social media, e.g. WhatsApp-groups, as supporting tools.

2. PROCEDURES

If you volunteer to participate in this study, we would ask you to do the following things:

- Join the WhatsApp groups when requested.
- Complete surveys on your usage of these tools.
- Be prepared to be interviewed one-on-one about the use of these tools.

You will be expected to use these tools for at least the length of your complete training programme (one short course / module).

Interviews will be completed during contact sessions, via electronic media such as WhatsApp, Google Hangouts, Adobe connect or via e-mail as last resort.

Surveys will be posted on-line through the Survey software of Stellenbosch University.

3. POTENTIAL RISKS AND DISCOMFORTS

The only possible inconvenience might be amount of WhatsApp messages sent by participants, although there is the possibility to hide the messaging service for periods of time. No serious risks or discomforts are foreseen. Participants may miss their WhatsApp groups outside of normal working hours.

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

Possible benefits of participation in this research are increased Web 2.0 skills and easy access to assistance with both your training course and on-site teaching from both lecturers, mentors and fellow teachers.

5. PAYMENT FOR PARTICIPATION

NONE

6. CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will not be disclosed only with your permission or as required by law. Confidentiality will be maintained by removing all teacher names, schools and towns. Any images or video material posted on the WhatsApp group will be anonymized (removing of faces and recognizable features such as school badges) if used in the dissemination of resulting papers.

Interviews will be recorded and transcribed. Participants have the right to review the transcriptions and request that certain parts not be used. After completion of the research these could be used for educational purposes, but anonymity will at all times be ensured.

7. PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so.

8. IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact Mrs Pauline Hanekom, Dr Maja Ndlovu or Dr Soria Strydom.

Mrs Pauline Hanekom:
078 [REDACTED]

Dr Maja Ndlovu:
021 [REDACTED]

Dr Soria Strydom:
021 [REDACTED]

9. RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not losing any legal claims, rights or remedies because of your participation in this research study. If you have any questions or concerns about the research, please contact Mrs Pauline Hanekom (info@sun.ac.za; 021 808 46223) at the Division for Research Development.

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The information above was described to _____ (*the participant*) by _____ in _____ [*Afrikaans/English/Xhosa/other*] and I am in command of this language or it was satisfactorily translated to me. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

I hereby consent voluntarily to participate in this study. I have been given a copy of this form.

Name of Subject/Participant

Name of Legal Representative (if applicable)

Signature of Subject/Participant or Legal Representative

Date

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to _____ [*name of the subject/participant*]. [*He/she*] was encouraged and given ample time to ask me any questions. This conversation was conducted in [*Afrikaans/*English*] and no translator was used.

Signature of Investigator

Date

ADDENDUM B: Copyright: Author permission letters

- Figure 1.2: Mr Nando Stöcklin
- Figure 4.3: Professor Susan McKenney

Figure 1.2: Mr Nando Stöcklin

From: [Nando Stöcklin](#)
To: [Hanekom, PW, Me \[pwh@sun.ac.za\]](#)
Subject: Re: Request to use diagram
Date: Monday, 15 October 2018 17:32:12
Attachments: [image008.png](#)
[image009.png](#)

Dear Pauline

Sure, feel free to use the image.

Thanks for asking!

Kind regards,
Nando

Am Mo., 15. Okt. 2018 um 16:50 Uhr schrieb Hanekom, PW, Me [pwh@sun.ac.za]
<pwh@sun.ac.za>:

Dear Sir,

I hereby request permission to use your EDR image on the webpage (<http://educationdesignresearch.de/wasistedr/>) in my PhD dissertation (with full referencing).

Kind regards

Pauline

Google Translate:

Lieber Herr,

Hiermit beantrage ich die Erlaubnis, Ihr EDR-Bild auf der Webseite (<http://educationdesignresearch.de/wasistedr/>) in meiner Dissertation zu verwenden (mit vollständiger Referenzierung).

Mit freundlichen Grüßen

Pauline

Mrs Pauline W. Hanekom | B.Sc (Hons) (Cytogenetics) (SU) | HDE (SU) | MEd
(Educational Support) (SU)
IKT ko rdineerder | ICT coordinator

ö

SUNSEP/Fakulteit Opvoedkunde | SUNCEP/Faculty of Education

e: pwh@sun.ac.za | t: +27 21 808 9197

a: G.G. Cillie Building | C/o. Crozier street and Ryneveld street



The integrity

and confidentiality of this email are governed by these terms. [Disclaimer](#)
Die integriteit en vertroulikheid van hierdie e-pos word deur die volgende bepaling bereël.
[Vrywaringsklousule](#)

--



Dr. Nando Stöcklin

| Spiel dein Leben - Spielerisch selbstbestimmt leben, lernen & arbeiten

| email: nando@spieldeinleben.ch

| site: spieldeinleben.ch

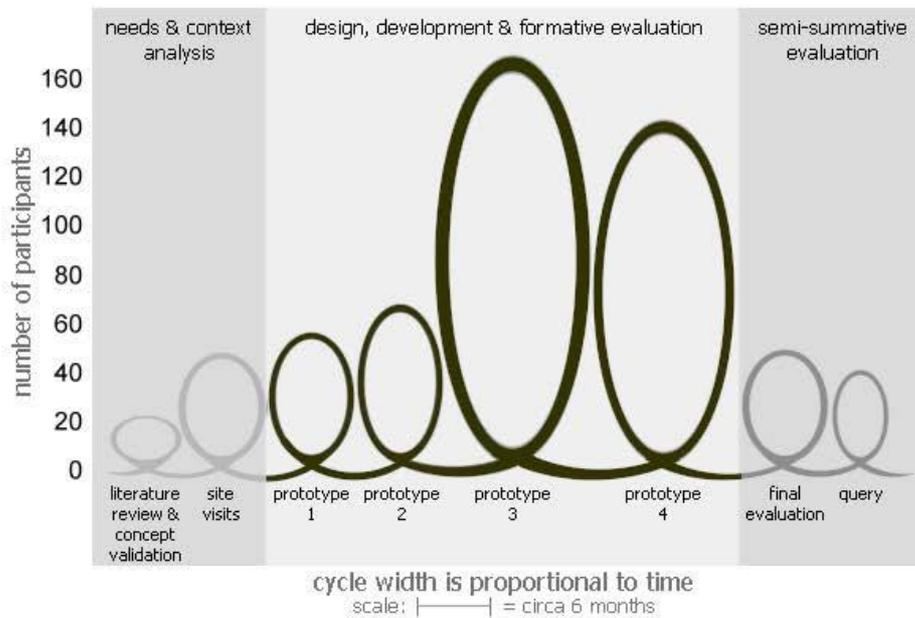


Figure 4.3: Professor Susan McKenney

Hanekom, PW, Me [pwh@sun.ac.za]

From: susan.mckenney@utwente.nl
Sent: Tuesday, 02 October 2018 5:44 PM
To: Hanekom, PW, Me [pwh@sun.ac.za]
Cc: Ndlovu, Mdu, Prof [mcn@sun.ac.za]; ndlovumc@gmail.com; Strydom, Sonja, Dr [sonjas@sun.ac.za]
Subject: Re: Copyright request
Attachments: F-Figure1.2.eps

Dear Pauline,
 Sure – you are welcome to use this figure, assuming that proper citation will be adhered to.
 I think I used photoshop originally, but am not certain.
 Below is what I have of the original, and attached is an eps of the version that shows up in our 2nd Edition (just out in September).
 Good luck with your study!
 All the best,
 Susan



From: "Hanekom, PW, Me [pwh@sun.ac.za]" <pwh@sun.ac.za>
Date: Tuesday, 2 October 2018 at 17:11
To: Me <susan.mckenney@utwente.nl>
Cc: "Ndlovu, Mdu, Prof [mcn@sun.ac.za]" <mcn@sun.ac.za>, "ndlovumc@gmail.com" <ndlovumc@gmail.com>, "Strydom, Sonja, Dr [sonjas@sun.ac.za]" <sonjas@sun.ac.za>
Subject: Copyright request

Dear Professor McKenney

I am a PhD student from South Africa using Design Based Research as Methodology. I hereby humbly request permission to use **Fig ES.2 Display of the CASCADE-SEA study**, in your published PhD, as an example of how DBR can be diagrammatically represented. And if you could be so kind as to inform me what programme was used to draw the iterative loops it would also be greatly appreciated.

Kind regards
Pauline

Mrs Pauline W. Hanekom | B.Sc (Hons) (Cytogenetics) (SU) | HDE (SU) | MEd (Educational Support) (SU)
IKT koördineerder | ICT coordinator

SUNSEP/Fakulteit Opvoedkunde | SUNCEP/Faculty of Education

e: pwh@sun.ac.za | t: +27 21 808 9197

a: G.G. Cillie Building | C/o, Crozier street and Ryneveld street



The integrity and confidentiality of this email are governed by these terms.

[Disclaimer](#)

Die integriteit en vertroulikheid van hierdie e-pos word deur die volgende

bepalings bereël. [Vrywaringsklousule](#)

ADDENDUM C: The VCoP validation questionnaire

- Permission letter from Murillo
- Murillo's questionnaire
- This study's questionnaire
- Reordered question list for analysis

Permission letter from Dr Enrique Murillo

Hanekom, PW, Me <pwh@sun.ac.za>

From: ENRIQUE MARTIN MURILLO OTHON <emurillo@itam.mx>
Sent: 16 March 2015 06:08 PM
To: Hanekom, PW, Me <pwh@sun.ac.za>
Subject: RE: Request: Permission to use and adapt survey instrument

Hi Pauline,

That sounds really neat!

You are very welcome to use and adapt my scales, just giving fair academic citation.

Good luck with your doctoral research, and let me know if there is anything else you need.

Enrique

Dr. Enrique Murillo
Department of Business Administration
Instituto Tecnológico Autónomo de México
Av. Camino a Sta. Teresa 930
Col. Héroes de Padiema
México, D.F., 10700
Tel. 5628-4056 Fax. 5490-4665
<http://itam.academia.edu/EMurillo>

De: Hanekom, PW, Me <pwh@sun.ac.za> [mailto:pwh@sun.ac.za]
Enviado el: lunes, 16 de marzo de 2015 05:41 a. m.
Para: ENRIQUE MARTIN MURILLO OTHON
Asunto: Request: Permission to use and adapt survey instrument

Dear Professor Murillo,

I am currently enrolled for PhD studies at the University of Stellenbosch, South Africa. The title of my study is: "Enhancing the effectiveness of in-service Senior Phase Natural Sciences and Mathematics teacher professional development by means of WhatsApp support. I'm researching Virtual Communities of Practice using WhatsApp as platform.

I read your article, "Searching Usenet for virtual communities of practice: using mixed methods to identify the constructs of Wenger's theory" and found your results extremely interesting. I would like to ask your permission to use (and adapt to my context) your "validated survey instrument" from appendix 1 in your article, in my research, please.

Kind regards
Pauline



Pauline W. Hanekom
Fasiliteerder E-Leer • Facilitator E-Learning
Sentrum vir Pedagogie • Centre for Pedagogy
Universiteit • Stellenbosch • University
Tel: 021 808 3482 • Faks/Fax: 021 808 3000
pwh@sun.ac.za / www.suncep.sun.ac.za

The integrity and confidentiality of this email is governed by these terms / Hierdie terme bepaal die integriteit en vertroulikheid van hierdie epos. <http://www.sun.ac.za/emaildisclaimer>
The integrity and confidentiality of this email is governed by these terms / Hierdie terme bepaal die integriteit en vertroulikheid van hierdie epos. <http://www.sun.ac.za/emaildisclaimer>

La información contenida en este mensaje de datos es confidencial, constituye un secreto industrial y/o profesional en términos de la legislación vigente y se encuentra dirigida exclusivamente al destinatario indicado en dicho mensaje. Si usted recibe esta información por error o si usted no es el destinatario del mensaje, favor de notificar al emisor, y destrúyalo.

The information contained in this electronic message is confidential, it constitutes a professional and/or industrial secret in terms of the current legislation, and is intended for its recipient only. If you receive this message by mistake or if you are not the recipient thereof, please notify the sender and destroy it.

Dr Enrique Murillo's (Murillo, 2008) Questionnaire

Appendix 1 - Validated survey instrument

The validated instrument is provided as a potential tool for future study of Internet-based communities of practice. It is organized into the original four thematic blocks and omits items discarded by EFA, hence its reduced size. Items are numbered according to their (randomized) position within each block, yet they are grouped under the validated scale they belong to. Sub-construct names appear on the right, although they should not normally be displayed in the survey itself.

Dear (Participant's name),	
This survey addresses knowledge sharing in news groups whose discussion is focused on a professional discipline (e.g., computer programming, financial planning, history, law, etc.). The survey is organized into four major topics containing 8-12 questions each, plus one open question and a few socio-demographic questions at the end. As you answer, please keep in mind the following conventions:	
"The profession" refers to the profession or discipline the news group is focused on. "Members of the news group" are people who post regularly to this news group.	
In addition, the following response codes are used throughout:	
SD = Strongly disagree D = Disagree N = Neutral A = Agree SA = Strongly agree	
learning THROUGH PARTICIPATION IN THE news group (12 items)	
1.11 Participation in this news group has increased my ability to quickly analyse a case or problem 1.7 Participation in this news group has improved my problem-solving skills 1.9 Participation in this news group has helped me to develop my own professional style 1.10 Participation in this news group has helped me to improve my skills 1.5 Participation in this news group has raised the level of professionalism I hold myself to	Improving professional skill
1.3 Participation in this news group has led me to acquire new knowledge 1.4 Participation in this news group has led me to develop new understanding 1.6 Participation in this news group has led me to acquire new insights	Acquiring new knowledge
1.12 On a professional level, I strongly identify with members of this news group 1.8 Part of my professional identity is continuing membership in this news group 1.1 Participation in this news group has expanded my stock of professional knowledge 1.2 Participation in this news group has helped me to develop my own professional viewpoint	Identifying with the profession
MEMBER INTERACTION IN THE news group (8 items)	
2.1 Members of this news group collaborate online to build solutions for real world problems or cases 2.4 Members of this news group are adept at combining individual contributions to build a solution for a problem or case 2.3 Messages posting difficult problems or cases will usually produce a collaborative effort from members of the news group to build a solution 2.6 Developing solutions to difficult problems or cases will usually involve the combined contributions of several members of the news group 2.8 The experience of this news group illustrates how collaborative online discussion can be an effective way of tackling difficult problems or cases	Collective problem-solving
2.5 I enjoy following the debates of issues that relate to the profession in the news group 2.2 I have learned a lot about the profession by watching members debate the issues 2.7 Debating issues with other members of the news group has helped me to build solid arguments	Debating domain-related issues
news group-SPECIFIC TOOLS AND STANDARDS (9 items)	
3.8 Members of this news group largely agree on criteria for evaluating quality in the profession 3.5 Members of this news group mostly follow the same professional standards 3.9 Members of this news group largely agree on what constitutes good and bad practice 3.3 Members of this news group largely agree on criteria for evaluating performance in the profession 3.1 Members of this news group largely agree on criteria for evaluating ethical conduct in the profession	shared criteria
3.6 This news group has best practices members often refer to 3.7 This news group has developed some new practices through discussion 3.2 Many members joined this news group mainly to learn how other practitioners do things 3.4 Members of the news group use technical language when discussing problems or cases	shared practices
COMMUNITY traits IN THE news group (11 items)	
4.4 Members of this news group see each other as trusted colleagues 4.3 Members of this news group share a mutual commitment to the aims of the news group 4.2 Members of this news group are comfortable asking each other for help 4.8 Members of this news group are highly committed to the profession 4.5 Members of this news group think of it as a stable community 4.1 Members of this news group have had online interaction with each other for years	shared sense of professional community
4.10 I know the other members of the news group very well 4.11 The other members of the news group know me very well 4.6 I have built strong ties with some members that I have never met in person 4.9 When I need specialized help or advice, I know which members of the news group I should ask 4.7 In my experience, you can get to know a person very well just from reading her/his messages often enough	Members' knowledge of each other
41. Open Question: Do you consider this news group a community and why?	
SOCIODEMOGRAPHIC QUESTIONS	
42. Please state your age 43. Please state your gender 44. Please state your profession 45. How long have you been a member of this news group (in months)? 46. How would you rate your expertise in the topic of this news group?	

Instrument 1: This study's VCoP validation questionnaire

[Sent out via SUSurvey]

Dear participant

The purpose of this survey is to gain information about professional knowledge sharing in teacher professional learning WhatsApp groups, where discussion is focussed on Natural Sciences teaching in the Senior Phase.

The survey is organised into four major categories containing 7 to 11 questions each, plus one open question and a few socio-demographic questions at the end.

Your identification other than asked in this survey will not be recorded in the survey and analysis.

As you answer, please keep the following conventions in mind:

- “The subject” refers to Natural Sciences “Members of the WhatsApp group” are the people who regularly comment or post on this WhatsApp group.

Please tick (x) the most appropriate code at each question. The codes that are used:



= Strongly disagree with the statement



= Disagree with the statement



= Neutral (only select neutral if you do not disagree or agree – it does not mean “I don’t know”)



= Agree with the statement



= Strongly agree with the statement

Please tick (x) the most appropriate code at each question.

Part 1: Learning through participation in the group					
1.1 Participation in this WhatsApp group has improved my teaching attitude.					
1.2 I believe that continuing membership in this WhatsApp group will help my professional growth.					
1.3 Participation in this WhatsApp group has increased my content knowledge of the subject.					
1.4 On a professional level I could strongly identify with this WhatsApp group.					
1.5 Participation in this WhatsApp group has improved my teaching skills.					
1.6 Participation in this WhatsApp group has increased my pedagogical knowledge of the subject.					
1.7 Participation in this WhatsApp group has helped me to develop my own professional viewpoint.					
1.8 Participation in this WhatsApp group has increased my professional knowledge of teaching.					
1.9 Participation in this WhatsApp group has improved my teaching style.					

Part 2: Member Interaction?					
2.1 Posting difficult problems or cases on the WhatsApp group usually produce collaborative effort from the members of the WhatsApp group to find a solution.					
2.2 I have learned a lot about the teaching profession by watching members of the WhatsApp group debate issues.					
2.3 The experience of this WhatsApp group shows how collaborative online discussions can be an effective method of solving teaching problems or cases.					
2.4 I enjoy following the debates on teaching issues that relate to the subject of the WhatsApp group.					

2.5	Members of the WhatsApp group collaborate online to find/build solution to real teaching problems.					
2.6	I contributed to many of the debates on teaching issues that relate to the subject of the WhatsApp group.					
2.7	Members of the WhatsApp group contribute solutions for a teaching problem or case.					

Part 3: WhatsApp group specific tools and standards						
3.1	Members of this WhatsApp group largely agree on criteria for evaluating performance in the teaching profession.					
3.2	This WhatsApp group has developed some new practices through discussions.					
3.3	Members of this WhatsApp group mostly follow the same professional standards.					
3.4	Members of this WhatsApp group use appropriate scientific/mathematical language when discussing teaching problems or cases.					
3.5	Members of this WhatsApp group largely agree on what represents good and bad practice in the teaching profession.					
3.6	This WhatsApp group often refers to best practices.					
3.7	Members of this WhatsApp group largely agree on criteria for evaluating ethical conduct in in the teaching profession.					

Part 4: Sense of community in the WhatsApp group						
4.1	Members of this WhatsApp group see each other as trusted colleagues.					

4.2	I know the other members of the WhatsApp group very well.					
4.3	Members of this WhatsApp group think of it as a stable community					
4.4	I have built strong ties with some of the members although I've only met them for a few days at the face-2-face sessions.					
4.5	Members of this WhatsApp group share a mutual commitment to the aims of the group.					
4.6	The other members of the WhatsApp group know me very well.					
4.7	When I need specialized help or advice, I know which members of the WhatsApp group I should ask.					
4.8	I have found that you can really get to know a person well from just reading her/his messages often enough.					
Part 4: Sense of community in the WhatsApp group (cont.)						
4.9	Members of this WhatsApp group are comfortable asking each other for help.					
4.10	Members of this WhatsApp group are highly committed to the teaching profession.					

Part 5: Open Question

Do you consider this WhatsApp group a community of learning? Explain.

Part 6: Sociodemographic questions

Age: _____

Highest Academic Qualification: _____

Gender: _____

Highest Professional Qualification: _____

How many years have you been teaching Natural Sciences? _____ years

How would you rate your expertise in the subject of this WhatsApp group? Read the rubric and then please tick (x) in a square (☐).

	NOVICE ☐	BEGINNER ☐	COMPETENT ☐	PROFICIENT ☐	EXPERT ☐
Knowledge	I have minimal, or “textbook” knowledge but cannot connect it to practice.	I have a working knowledge of key aspects of practice.	I have a good working and background knowledge of area of practice.	I have a depth of understanding of the discipline and area of practice.	I have authoritative knowledge of discipline and deep tacit understanding across area of practice.
Standard of work	Unlikely to be satisfactory unless closely supervised as I do not know enough yet.	Straight-forward tasks likely to be completed to an acceptable standard.	Fit for purpose, though may lack refinement.	Fully acceptable standard achieved routinely.	Excellence achieved with relative ease.
Autonomy	I still needs close supervision or instruction.	I am able to achieve some steps using own judgement, but supervision needed for overall task.	I am able to achieve most tasks using own judgement.	I am able to take full responsibility for my own work (and that of others where applicable).	I am able to take responsibility for going beyond existing standards and creating own interpretations.
Copying with complexity	I have little or no conception of dealing with complexity within this subject practice.	I appreciate complex situations but am only able to achieve partial resolution.	I can cope with complex situations through deliberate analysis and planning.	I deal with complex situations holistically, I am quite confident in decision-making around this subject.	I have a holistic grasp of complex situations, and move between intuitive and analytical approaches with ease.
Perception of context	I tend to see actions within this subject practice in isolation.	I still see actions within this subject practice as a series of steps.	I see actions at least partly in terms of longer-term goals.	I see the overall ‘picture’ and how individual actions fit within it.	I see the overall ‘picture’ and alternative approaches; vision of what may be possible.

(Adapted from the professional standards for conservation, Institute of Conservation (London) 2003 based on the Dreyfus model of skill acquisition.)

Reordered question list for analysis**Instrument to validate formation of a Community of Practice.****Part 1: Learning through participation in the CoP**

Improving professional skills	Participation in this WhatsApp group has improved my teaching skills.	1.5
	Participation in this WhatsApp group has raised the level of professionalism I hold myself to.	1.10
	Participation in this WhatsApp group has improved my teaching attitude.	1.1
	Participation in this WhatsApp group has improved my teaching style.	1.9
Acquiring new knowledge	Participation in this WhatsApp group has increased my content knowledge of the subject.	1.3
	Participation in this WhatsApp group has increased my pedagogical knowledge of the subject.	1.6
	Participation in this WhatsApp group has increased my understanding of teaching the subject.	1.11
Identifying with the profession	On a professional level I could strongly identify with the members of this WhatsApp group.	1.4
	I believe that continuing membership in this WhatsApp group will help my professional growth.	1.2
	Participation in this WhatsApp group has increased my professional knowledge of teaching.	1.8
	Participation in this WhatsApp group has helped me to develop my own professional viewpoint of teaching.	1.7

Part 2: Member interaction in the CoP

Collective problem solving	Members of the WhatsApp group collaborate online to find/build solution to real teaching problems.	2.5
	Members of the WhatsApp group contribute solutions for teaching problems shared on the group.	2.7
	Messages of difficult teaching problems posted on the group usually produce collaborative effort from the members of the WhatsApp group to find a solution.	2.1
	The experience of this WhatsApp group shows how collaborative online discussions can be an effective method of solving teaching problems.	2.3
Debating domain-related issues	I enjoy following the debates on teaching issues that relate to the subject of the WhatsApp group.	2.4
	I have learned a lot about the teaching profession by watching members of the WhatsApp group debate issues.	2.2
	I contributed to the debates on teaching issues that relate to the subject of the WhatsApp group.	2.6

Part 3: WhatsApp group specific tools and standards

Shared criteria	Members of this WhatsApp group mostly follow the same professional standards.	3.3
	Members of this WhatsApp group largely agree on what represents good and bad practice in the teaching profession.	3.5
	Members of this WhatsApp group largely agree on criteria for evaluating performance in the teaching profession.	3.1
	Members of this WhatsApp group largely agree on criteria for evaluating ethical conduct in in the teaching profession.	3.7
Shared practices	This WhatsApp group often refer to best practices.	3.6
	Members of this WhatsApp group has developed some new practices through discussions.	3.2
	Members of this WhatsApp group use appropriate scientific/mathematical language when discussing teaching problems or cases.	3.4

Part 4: Sense of community in the CoP

Shared sense of professional community	Members of this WhatsApp group see each other as trusted colleagues.	4.1
	Members of this WhatsApp group share a mutual commitment to the aims of the group.	4.5
	Members of this WhatsApp group are comfortable asking each other for help.	4.9
	Members of this WhatsApp group are highly committed to the teaching profession.	4.10
	Members of this WhatsApp group think of it as a stable community	4.3
Members' knowledge of each other	I know the other members of the WhatsApp group very well.	4.2
	The other members of the WhatsApp group know me very well.	4.6
	I have built strong professional ties with some of the members although I have only met them for a few days at the face-2-face sessions.	4.4
	When I need specialized help or advice, I know which members of the WhatsApp group I should ask.	4.7
	I have found that you can really get to know a person well from just reading her/his messages often enough.	4.8

ADDENDUM D: The semi-structured interview schedule

- Interview schedule for Cycle 1
- Interview schedule for Cycle 2
- Interview schedule for Cycle 3

Interview schedule for Cycle 1

INTERVIEW PROTOCOL of the semi-structured interviews

Interviewee copy (pg. 1 and 2)

Thank you for agreeing to participate in the interviews. The interview setting will be via cellular phone and the conversation will be recorded.

a. Introduction and verification of your sociodemographic data

Your Pseudonym	Teacher #									
Your age group	20-29		30-39		40-49		50-59		60-69	
Your gender	Male			Female			Other			
Your WhatsApp group name										
Your Highest Academic Qualification										
Your Highest Professional Qualification										
Years teaching subject										
Your Teacher expertise level	Novice		Beginner		Competent		Proficient		Expert	
The interviewer (Investigator)	Pauline W. Hanekom									
Date of Interview										
Time of Day of Interview										
Type	Individual Interview									
Project Description	You agreed to participate in a research study conducted by Mrs Pauline Wilna Hanekom, from the Stellenbosch University Centre for Pedagogy: Enhancing the effectiveness of in-service Senior Phase Natural Sciences teacher professional development by means of WhatsApp support. Each interview is expected to last for approximately half an hour. Thank you once again for agreeing to participate.									

b. What was your expectations of the course and joining the WhatsApp group at the start of the short course?

You can use this space to write down some thoughts before the interview starts:

c. Guidelines for the interview/discussion:

1. What was your expectations of the course and joining the WhatsApp group at the start of the short course?
2. Do you feel your WhatsApp participation increased the effectiveness of the short course?
3. Do you feel the support given via WhatsApp supported your needs and interests during the course?
4. Do you think the academic support through the posted questions, discussions and video material were
 - a. appropriate?
 - b. helpful to your professional learning?
5. Do you feel your WhatsApp participation supported you with resources relevant to your classroom context?
 - a. Did you adapt any course material for use in your class?
 - b. Have you changed your classroom practise in any way as a result of this course? How?
6. Do you feel your WhatsApp participation enhanced your pedagogical content knowledge? How?
7. Do you feel engaging in a WhatsApp group academic discussion is a form of active learning? Why?
8. Were problems and questions on the WhatsApp group addressed quickly and efficiently? Example?
9. Do you feel the support given via WhatsApp impacted your learners in any way? How?
10. Do you think engaging in a WhatsApp group allowed the participants to share and discuss the implementation of your new knowledge and skills with each other?

TEACHER EXPERTISE LEVELS

	NOVICE	BEGINNER	COMPETENT	PROFICIENT	EXPERT
Knowledge	I have minimal, or “textbook” knowledge but cannot connect it to practice.	I have a working knowledge of key aspects of practice.	I have a good working and background knowledge of area of practice.	I have a depth of understanding of the discipline and area of practice.	I have authoritative knowledge of discipline and deep tacit understanding across area of practice.
Standard of work	Unlikely to be satisfactory unless closely supervised as I do not know enough yet.	Straight-forward tasks likely to be completed to an acceptable standard.	Fit for purpose, though may lack refinement.	Fully acceptable standard achieved routinely.	Excellence achieved with relative ease.
Autonomy	I still needs close supervision or instruction.	I am able to achieve some steps using own judgement, but supervision needed for overall task.	I am able to achieve most tasks using own judgement.	I am able to take full responsibility for my own work (and that of others where applicable).	I am able to take responsibility for going beyond existing standards and creating own interpretations.
Copying with complexity	I have little or no conception of dealing with complexity within this subject practice.	I appreciate complex situations but am only able to achieve partial resolution.	I can copeswith complex situations through deliberate analysis and planning.	I deal with complex situations holistically, I am quite confident in decision-making around this subject.	I have an holistic grasp of complex situations, and move between intuitive and analytical approaches with ease.
Perception of context	I tend to see actions within this subject practice in isolation.	I still see actions within this subject practice as a series of steps.	I see actions at least partly in terms of longer-term goals.	I see the overall ‘picture’ and how individual actions fit within it.	I see the overall ‘picture’ and alternative approaches; vision of what may be possible.

(Adapted from the professional standards for conservation, Institute of Conservation (London) 2003 based on the Dreyfus model of skill acquisition.)

Interview schedule for Cycle 2 and 3

INTERVIEW PROTOCOL of the semi-structured interviews

Interviewee copy (pg. 1 and 2)

Thank you for agreeing to participate in the interviews. The interview setting will be via a cellular phone application (app), which allows for recording of the conversation.

a. Introduction and verification of your sociodemographic data

Your Pseudonym	Teacher #									
Your age group	20-29		30-39		40-49		50-59		60-69	
Your gender	Male			Female			Other			
Your WhatsApp group name										
Your Highest Academic Qualification										
Your Highest Professional Qualification										
Years teaching subject										
Your Teacher expertise level	Novice		Beginner		Competent		Proficient		Expert	
The interviewer (Investigator)	Pauline W. Hanekom									
Date of Interview										
Time of Day of Interview										
Type	Individual Interview									
Project Description	You agreed to participate in a research study conducted by Mrs Pauline Wilna Hanekom, from the Stellenbosch University Centre for Pedagogy: Enhancing the effectiveness of in-service Senior Phase Natural and Life Sciences teacher professional development by means of WhatsApp support. Each interview is expected to last for approximately half an hour. Thank you once again for agreeing to participate.									

b. What was your expectations of the course and joining the WhatsApp group at the start of the short course?

You can use this space to write down some thoughts before the interview starts:

c. Guidelines for the interview/discussion:

1. What was your expectations of the course and joining the WhatsApp group at the start of the short course?
2. Do you feel your WhatsApp participation increased the effectiveness of the short course?
3. Do you feel the support given via WhatsApp supported your needs and interests during the course?
4. Do you think the academic support through the posted questions, discussions and video material were
 - a. appropriate?
 - b. helpful to your professional learning?
5. Do you feel your WhatsApp participation supported you with resources relevant to your classroom context?
 - a. Did you adapt any course material for use in your class?
 - b. Have you changed your classroom practise in any way as a result of this course? How?
6. Do you feel your WhatsApp participation enhanced your pedagogical content knowledge? How?
7. Do you think engaging in a WhatsApp group academic discussion is a form of active learning? Why?
8. Were problems and questions on the WhatsApp group addressed quickly and efficiently? Example?
9. Do you feel the support given via WhatsApp impacted your learners in any way? How?
10. Do you think engaging in a WhatsApp group allowed the participants to share and discuss the implementation of your new knowledge and skills with each other?

TEACHER EXPERTISE LEVELS

	NOVICE	BEGINNER	COMPETENT	PROFICIENT	EXPERT
Knowledge	I have minimal, or “textbook” knowledge but cannot connect it to practice.	I have a working knowledge of key aspects of practice.	I have a good working and background knowledge of area of practice.	I have a depth of understanding of the discipline and area of practice.	I have authoritative knowledge of discipline and deep tacit understanding across area of practice.
Standard of work	Unlikely to be satisfactory unless closely supervised as I do not know enough yet.	Straight-forward tasks likely to be completed to an acceptable standard.	Fit for purpose, though may lack refinement.	Fully acceptable standard achieved routinely.	Excellence achieved with relative ease.
Autonomy	I still needs close supervision or instruction.	I am able to achieve some steps using own judgement, but supervision needed for overall task.	I am able to achieve most tasks using own judgement.	I am able to take full responsibility for my own work (and that of others where applicable).	I am able to take responsibility for going beyond existing standards and creating own interpretations.
Copying with complexity	I have little or no conception of dealing with complexity within this subject practice.	I appreciate complex situations but am only able to achieve partial resolution.	I can copewith complex situations through deliberate analysis and planning.	I deal with complex situations holistically, I am quite confident in decision-making around this subject.	I have an holistic grasp of complex situations, and move between intuitive and analytical approaches with ease.
Perception of context	I tend to see actions within this subject practice in isolation.	I still see actions within this subject practice as a series of steps.	I see actions at least partly in terms of longer-term goals.	I see the overall ‘picture’ and how individual actions fit within it.	I see the overall ‘picture’ and alternative approaches; vision of what may be possible.

(Adapted from the professional standards for conservation, Institute of Conservation (London) 2003 based on the Dreyfus model of skill acquisition.)

ADDENDUM E: Example of a mapping matrix

Build Cycle 1		CONTEXT timeframe quote was made * timeframe quote refers to ^					CATEGORY WITH SUMMARIES AND QUOTES	EMERGING THEMES	MEMOS
CODES	group participant/s	Before contact session	During or at end of contact sessions	Between contact sessions	During or at end of telematic sessions	After end of course, near end of cycle	WhatsApp (WA) participant's reaction to the use of the WA group within TPL programme (on WA or in interview (INT))		
#logistics	Teachers: 16, 6, 14		*^				6:43, 10:5 (INT), 14:1 (INT) General satisfaction about use, different kinds of info can be shared via WA messages <i>Ja-nee, dit het beslis my behoeftes en belange ondersteun.</i> [Yes, it definitely supported my needs and interests] (10:5 - T6)	general logistics: Refers to participants demonstrating their general satisfaction with use of WA	
	Teachers: 6, 13, 14					*^	10:2 (INT), 11:1 (INT), 11:6 (INT), 14:1 (INT) info can be shared between students via WA messages <i>...ek kan van my kant af belangrike inligting deurgee of 'n idee wat ek het kan ek deurgee...</i> [From my side I could share important information or I could share an idea that I had cananother thing...(10:2 - T6) <i>...soos byvoorbeeld jy werk saam met jou klas en jy kan vinnig iets deel...</i> [for example when you are working with your class you could quickly share something] (11:6 - T13) <i>En jy weet mense kan goedkoper...uhm...op 'n goedkoper manier met mekaar gesels, al is hul nie bymekaar nie.</i> (14:1 - T14)	WA communication between students: Refers to participants demonstrating their satisfaction with being able to communicate with each other via WA	Reasons why satisfied: communication is fast, effective and cheap way to share information
	Teacher: 9, 10, 16		*^		*^		6:74, 6:41, 6:38, 6:206, 8:16 (INT) logistics communication <i>I think we must thank you again for all your support, quick responses and good communication!! Op jul kop! !</i> (6:38: T10) <i>image: telematic roll-call</i> (6:206 - T10)	WA communication of logistics: Refers to participants demonstrating their satisfaction with how logistics were communicated via WA	fast, new way of sharing logistics (media)
#content choice	Teacher 6, 46, 3					*^	10:8 (INT), 9:6 (INT) Teachers were exposed to material and skills that supported the curriculum and were relevant. <i>...die kursus was baie ryk aan inhoud...uhm...praktiese aktiwiteite...dit het regtigwaar dit wat voorgeskryf was in die KABV dit het dit regtigwaar gesteen.</i> (10:8 - T6) The WhatsApp group formed part of ICT skills training. <i>kind of integrating with the ICT skills and that is what is mostly needed in the teaching know</i> (13:2 - T3)	curriculum content: Refers to participants demonstrate their satisfaction with course content, posted on WA group, aligning to the curriculum.	reasons why satisfied: relevance and ICT integration skills
	Teacher: 14					*^	14:4 (INT) general content satisfaction <i>ek was regtig waar...uhm...diep beindruk jy weet, met die materiaal</i> (14:4 - T14)	general content: Refers to participants demonstrating their general satisfaction with course content posted on WA group	
#language	Teacher: 8	*^					6:6 Participants positive about the use of only English language on group <i>Excellent .I like your comment</i> (6:6 - T8)	inclusive language use: Refers to the ability of participants to demonstrate their level of satisfaction with language use on WA group	
	Teacher: 13			^		*	11:7 (INT) Someone in group can translate if you don't have time <i>...as ek nou vat ek het miskien iets in Afrikaans gesê, en ander wat nou...uhm...Engelssprekend was...dan kan iemand anders weer gehelp het om byvoorbeeld te translate ...</i> (11:7 - T13)	inclusive language use: Refers to the ability of participants to demonstrate their level of satisfaction with language use on WA group	
	Teachers: 46, 3		^*				6:402, 6:403 Defusing of language issue between participants. Afrikaans speaking teacher to isiXhosa speaking teachers. <i>Ndithetha kancinci kadwa andicomplain!!</i> [trans. I speak little bit, but I don't complain] (6:402 - T46) <i>thankx you make feel safe and welcome</i> (6:403 - T.3)	inclusive language use: Refers to the ability of participants to demonstrate their level of satisfaction with language use on WA group	
#knowledgeability	Teacher: 7					*^	6:368 Positive participants perceptions in response to facilitator posted news items that linked to the curriculum <i>Thank for the info! You are truley team awesome!!!!</i> (6:368-T7)	General knowledgeability: Refers to the ability of participants to demonstrate their level of satisfaction with facilitator knowledgeability and helpfulness	
	Teacher: 16					^*	8:7 (INT) Facilitators described as willing to answer, respectful and supportive. <i>...die manier hoe julle...uhm...te werk gegaan het om vir ons...oor te dra wat nodig was, was vir my puik gewees. En julle het dit net verder extend op die...op die WhatsApp groep...</i> (8:7-T16)	General knowledgeability: Refers to the ability of participants to demonstrate their level of satisfaction with facilitator knowledgeability and helpfulness	
	Teacher 14					^*	14:9 (INT) <i>...die manier hoe dinge oorgepra was, jy weet, op 'n toepaslike wyse en...enne...jy weet dis natuurlik grootmense...volwassesnes wat op 'n ander manier leer...enne...definitief...dit was op ons vlak gewees..</i> (14:9 - T14)	Andragogic knowledgeability: Refers to participants demonstrating their satisfaction with the facilitators' method and practice of teaching adult learners	

Abbreviations:

(INT) Interview

(#:# - T#) E.g. (11:7 – T13)

The first number (11:7) is the quote label from Atlas.ti. The second letter-number combination (T13) is the teacher pseudonym.

ADDENDUM F: Doctoral timeframe documentation

- E-mail from Prof Christa van der Walt: Vice-Dean Research regarding the maximum years of doctoral study within SU Faculty of Education

Le Roux, M, Mrs [mlr1@sun.ac.za]

From: Van der Walt, Christa, Prof [cvdwalt@sun.ac.za]
Sent: 11 March 2019 13:50
To: Le Roux, M, Mrs [mlr1@sun.ac.za]
Subject: Postgraduate students: Reports on progress

Hi Sally

Sal jy asseblief hierdie boodskap vir die nagraadse studente aanstuur en dan vir al die personeel vir hulle aandag?

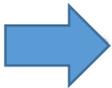
Dankie!
Christa

Dear Postgraduate Student

REPORTING ON PROGRESS WITH STUDIES

I hope that you are keeping well and that you feel inspired to make progress with your research project.

I'm writing to let you know that the Education Faculty took a decision at the end of 2018 that all Masters and PhD students should report on their progress twice per year: at the beginning of June again at the start of November. When the time comes, you will receive a reminder and a form that you need to complete. The purpose of this exercise is to encourage you and your supervisor to keep your studies in the forefront of your mind. It is important for all of us that students make progress and that they do not waste their money by registering again and again without making any progress.



Please remember that there is a limit to the time that you can re-register for your degree: three years for a Masters and five years for a PhD. At the end of the second year of the Masters, and at the end of the fourth year of the PhD, you will receive a letter to remind you that you have a year left for your study.

We acknowledge that it is not easy to do postgraduate studies. If you are not on campus, it can become a lonely journey and students may lose momentum. I would like to encourage you to join our postgraduate Saturdays, where you can talk to fellow students and build a support network. This is how you get energy for your study. We are also in the process of creating a website where we will post recordings of the Saturday presentations, so that those of you who cannot attend, are able to access the workshops.

If you find that your personal circumstances are such that you cannot continue, please talk to your supervisor/promotor, because they will be able to advise you, possibly by suggesting that you interrupt your studies for a year.

I wish you a productive study year and hope to see you walk across the stage soon!

Yours sincerely

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