



An exploratory study: Testing the effectiveness of a live-streamed lecture at tertiary level for accounting students

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Orientation: Unrest on South African higher education campuses compelled universities to search for alternatives to traditional physical lectures.

Research purpose: This study investigated whether live-streamed lectures could be an effective *ad hoc* alternative for accounting students at a South African university.

Motivation for the study: An alternative to physical lectures is necessary to ensure that the academic programme can continue and student performance be maintained during times when classes are disrupted.

Research design/approach and method: A randomised control trial was chosen as the method to test the effectiveness of a live-streamed lecture. Participants were randomly allocated to attend either the physical accounting lecture or the synchronous live-streamed lecture. A comprehension test followed the said lecture for all participants.

Main findings: The results of the test revealed that participants who live-streamed the lecture performed better than participants who attended the physical lecture. Gender was not a determining factor for the difference in performance when making use of live-streaming facilities, but race and background might influence performance. The majority of participants who live-streamed the lecture stated that they focused better with live streaming than they normally do in the class.

Practical/managerial implications: Tertiary institutions are advised to acquire or implement live-streaming solutions that will help to ensure that classes can continue undisturbed during unrest on campus.

Contribution/value-add: It was concluded that live streaming could uphold student performance when used temporarily in unusual circumstances.

Introduction

Student performance at tertiary institutions is constantly on the agenda in South Africa. It is commonly known that class attendance improves student performance (Gerber, Mans-Kemp & Schlechter 2013; Kahu & Nelson 2018; Rossouw 2018). Student protests during the #FeesMustFall campaign that started in 2015 disrupted classes to such an extent that the academic programme in some universities had to be postponed by the end of 2016 (Hodes 2016). A viable alternative is necessary as an interim solution when classes are disrupted sporadically to ensure that the academic programme can continue and student performance be maintained despite such occurrences.

Live-streaming lectures provide such an alternative. The perceptions and views on the live-streaming lectures have been researched extensively in the past (Bennet & Glover 2008; Fredriksen 2015; Kahu & Nelson 2018; Sader & Gabela 2017). Not many studies, however, report on the effectiveness of live-streaming when it is used on a temporary basis as an alternative to physical classes when extraordinary circumstances occur. Furthermore, stringent time constraints in most courses (and especially for accounting courses) necessitate the continuation of the academic programme to complete the syllabus within an academic year. Even though a new generation of students, who is perceived to be well adjusted to and knowledgeable in the use of technology, is currently sitting in classrooms at universities, live-streaming could only really be considered as a viable alternative if it sustains student performance.

Research objective and limitations

Research objective

The objective of this research was to investigate whether a lecture that has been live-streamed to accounting students could be an effective alternative to physical classes, on an *ad hoc* basis,

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to ensure that the academic programme can continue at all times. The effectiveness of a live-streamed lecture was measured with the use of a comprehension test. Students' ability to listen or concentrate on content while not being in the class physically had to be compared with students' normal academic routine of attending lectures physically. A randomised control trial was chosen as the method to test the effectiveness, and the following research questions were developed to structure the results of quantitative and qualitative data collected:

- What is the effect of a live-streamed lecture on student performance?
- What are students' experiences of the live-streamed lecture?

Research limitations

The study was conducted at a residential university where it is the norm for accounting students to attend physical class for their academic content. The study did not address other impediments to class attendance or the option of Massive Online Open Courses to replace traditional classes.

During unrest on campus, students will be exposed to an off-campus environment. Communication between lecturers and students will have to be clear to ensure that students can join the live-streamed lecture at the correct time. This study purposefully live-streamed the lecture to a controlled environment in an attempt to ensure that the results are comparable between the venues. The researchers acknowledge the fact that students would have to live-stream lectures from their home, residence or flat when classes are interrupted and that some students might not have the necessary devices (i.e. computer, laptop or cell phone) to live-stream the lecture from. This limitation could be addressed by also recording a live-streamed lecture and making it available to all students so that they can access the information at a later stage. This study assumes that lecturers will be able to find a platform from which to broadcast the live-streaming.

The randomised control trial was only applied to one lecture and not over a period of time. The results of this study should not be extrapolated to other courses without cause.

Literature review

Background

Student performance has been researched extensively in the past, and for good reason. All tertiary institutions want their students to succeed and therefore want to maximise their efforts to assist students to obtain their desired degree. There are many factors that impact student performance. One of the factors that contribute towards student performance, and ultimately student success, is class attendance and engaging with the content being lectured. The literature has proven that higher student engagement and participation in class result in higher success rates for students (Gerber et al. 2013; Kahu & Nelson 2018). A recent study supports these findings

where students and lecturers at a South African university indicated a strong belief that class attendance plays a big role in student success (Rossouw 2018). First-year students also attested to the importance of class attendance. They stated that it is better for them to learn in class (possibly because it is similar to their school experience) than on their own (Jordaan 2009; Van Schalkwyk, Menkveld & Ruiters 2010). In accounting education specifically, physical contact sessions are considered to be the most important resource in the teaching and learning experience (De Lange, Marx & Van der Watt 2013).

At the end of 2015, the #FeesMustFall student protests disrupted the academic programmes of most South African universities and by October 2016 the academic year had to be postponed at some of these universities (Hodes 2016). Traditional accounting curriculums at tertiary institutions are very demanding and time-consuming (Smit & Steenkamp 2015). Therefore, cancelling even one lecture as a result of class disruptions places enormous pressure on lecturers to finish the curriculum in time. Together with recent class disruptions, the Department of Higher Education and Training (DHET) also raised concerns about the high dropout percentage of higher education students (DHET 2017). They have instructed universities to address the matter of student performance, *inter alia* by providing support programmes (DHET 2017). The need to find an alternative to physical class attendance and to address student success simultaneously is therefore emphasised by recent events.

It is important to understand the needs and types of students that are currently attending university to find such an alternative to support and/or enhance throughput rates. The majority of students who are currently studying at tertiary institutions are between the ages of 17 and 22, therefore born between 1995 and 2000. They are considered to be Generation Y students. Generation Y is generally defined as being born between 1982 and 2002 (Hills et al. 2015). These students are perceived to be visual learners (Weiler 2004). They are also considered to be the first generation to have grown up with technology (De Lange et al. 2013). Lai and Hong (2015) found that even though the new generation of students are seemingly 'highly skilled in digital technologies', they do not seem to make significant use of technology for learning. The students who do use technology for academic purposes experience that the use of technology gives them flexibility of location, it helps them to manage the logistics of studying and it helps them to save time, among other reasons (Henderson, Selwyn & Aston 2017).

It is therefore deemed worthwhile to investigate the use of technology as an *ad hoc* alternative to physical class attendance. The use of technology has been widely discussed in the literature, with differing opinions and results. Many studies have found that students have a preference for physical lecturers (Bennet & Glover 2008; Hills et al. 2017). In contrast, Rossouw (2018) recently tested the perceptions of students and lecturers on the possibility of using technology

for learning through live-streaming facilities and found that a convincing 90% of students were willing to make use of such facilities. The main arguments in favour of live-streaming included convenience of own space and better focus (Rossouw 2018). Gezgin, Adnan and Acar Guvendir (2018) also found that students in general have a positive attitude towards the use of technology in learning. Electronic interventions must, however, be planned carefully and include support to lecturers and students for it to have the desired effect (Frindt 2007).

Live-streaming lectures as an alternative to physical classes

Live-streaming facilities fall under the umbrella term 'distance education' (DE). According to Abdous and Yen (2010), DE ranges from remote broadcasts to mobile learning. Distance education can be provided synchronously (same-time interaction) or asynchronously (Owens, Hardcastle & Richardson 2009). Live-streaming lectures are provided synchronously, where there is no need to download the content before it can be viewed as it is delivered directly over a network (Yang & Liu 2007). The use of live-streaming facilities will therefore ensure that a student still attends the class (i.e. remotely and not being in the class physically), but that he or she does not have to risk coming to campus when there are disruptions.

In a study by Owens et al. (2009), it was found that remote students experienced a sense of isolation – not socially per se, but they felt that they could not share optimally in the learning experience. Yang and Liu's (2007) study also found that students are concerned about loss of interactivity when not attending physical classes. They went on to report that both students and lecturers believe that live-streaming can support learning but cannot be a substitute for face-to-face interaction.

The effect of live-streaming on student performance

In statistics released by the DHET in South Africa, African, mixed race and Indian students have significantly lower pass rates than white students (DHET 2017). Background and gender might play an important role in a student's performance when making use of live-streaming facilities. Students from a disadvantaged background generally do not have access to computers at school level and might feel insecure in the use of technology (Sader & Gabela 2017). Sader and Gabela (2017) define previously disadvantaged students as 'female, poor, disabled and black'. The fact that these students feel insecure regarding their technological capabilities can increase their anxiety and possibly have a negative effect on their performance (Kahu & Nelson 2018). Carrick et al. (2017) report that students from rural areas prefer physical lectures over online learning. This can conceivably be as a result of their limited exposure to technology. All universities accredited by the South African Institute of Chartered Accountants (SAICA) present Information Technology (IT) modules as part of their

Chartered Accountant (South Africa) (CA [SA]) course (Smit & Steenkamp 2015). The majority of accounting students should therefore be comfortable to work with basic technology, as was seen in the results of Smit and Steenkamp (2015), where students rated their understanding of IT as well developed. Accounting students studying towards becoming a CA (SA) should also be able to master the pervasive skill of adapting to change Strauss-Keevy (2014) and Smit and Steenkamp (2015). The use of live-streaming should therefore not be entirely out of reach in terms of these students' skills.

It has been reported that female students attend and enjoy class more than male students (Jordaan 2009). In South Africa, statistics also show that female students perform better than male students in undergraduate studies (DHET 2017). In addition to performing better than their counterparts, females also seem to favour technology for their learning experience more than male students do. Gezgin et al. (2018) found that female students have a more positive attitude towards the practicality of the use of technology in learning. This confirms the results of Jackson et al. (2008) that females would rather use the Internet for academic purposes than males. Interestingly enough, Carrick et al. (2017) found that female students perform better than male students in physical classes, but they perform similar to male students for live-streamed lectures.

Bennet and Glover (2008) found that the live-streaming lectures promoted learning with no significant differences in students' results. In another study, students tended to fall behind and the average mark for students dropped when streaming was the only option available to them (Fredriksen 2015). It is evident from the literature that live-streaming, especially when introducing such facilities for the first time, should not be used in isolation or as the only option for delivering class content. This study opts to test the effectiveness of an *ad hoc* live-streamed lecture and not live-streaming as alternative mode for learning.

Research methodology

Context, research design and participant management

This study was conducted at the Faculty of Economic and Management Sciences (EMS) of Stellenbosch University (SU). Live-streaming lectures are not yet considered a common practice in the EMS Faculty at SU. At the time of this study, only the School of Accountancy had introduced live-streaming facilities to first- and second-year students in the Bachelor of Accounting (BAcc) programme (students studying towards becoming a CA [SA]) on a very limited basis. Registered students at SU have access to their course content through the university's intranet. This study used Adobe Connect as a platform on the university intranet to live-stream the lecture. Access to the live-streamed lecture was therefore limited to students who were registered for the course.

In an attempt to compare homogenous data, only first-year BAcc students attending lectures, where English is the language of instruction, were targeted for participation. The target audience is administered in two groups at SU as a result of the large student numbers for the first-year BAcc course and especially students who want to receive instruction for this course in English. Both groups receive the same lecture, but they attend class in different time slots. It was not possible to target only one of these groups for this study, seeing that students attend their classes between the available time slots for the two groups interchangeably. The BAcc course at SU is also presented in Afrikaans. The Afrikaans class receives lectures in the same time slots and therefore by a different lecturer. In an attempt to minimise variables, the researchers only targeted students receiving instruction in English.

The research design is based on the principles of a randomised controlled trial to test the effectiveness of a live-streamed lecture. The specific lecture chosen for this study was presented in class physically while being live-streamed simultaneously. This lecture will henceforth be referred to as class X. Class X included content that first-year BAcc students would not have encountered previously (except for repeating BAcc students who are not deemed to have a significant advantage above other first-year students, considering that they are repeating an academic year). The subject lectured in class X was financial accounting.

Participants were allocated to the venues based on a random selection. The random selection was done with the Excel 'Rand' function which evenly distributes random numbers (to participants who volunteered) greater than zero and less than one. The random numbers were sorted from lowest to highest. Half of the participants were allocated to attend class X physically, while the other half was allocated to live-stream the lecture. This was done to minimise bias, on the assumption that when students are randomly selected all other variables with an influence on their performance other than the lecture in this study are evenly distributed between the groups (Mann 2003). Participants who attended class X physically were considered to be the control group, seeing that physical class attendance is the norm for these participants. Participants who were randomly selected to live-stream class X were instructed to go to an electronic classroom. The designated electronic classroom was only accessible to participants of this study. The hardware and software in the electronic classroom were adequately equipped to live-stream the lecture ensuring that no technical failure could impede the results. Participants in the electronic classroom were supervised and data collection for these participants was also monitored. The purpose of supervision in the electronic classroom was twofold: firstly to ensure that there were no technical failures that could prevent the study of continuing and secondly to ensure that participants who live-streamed the lecture did not use any resources to answer the comprehension test. By using a supervisor in this way the researchers ensured that the conditions in which participants

answered the comprehension test were similar between the two venues. Class X was presented to both first-year BAcc groups who receive instruction in English by the same lecturer on the same day, but at different times. During *ad hoc* class interruptions, students would not necessarily have access to electronic classrooms on campus. A controlled environment was nonetheless chosen for this study to ensure all participants had access to the correct technology and to invigilate the comprehension test.

Participant recruitment started with an announcement in class where students were informed of the research study and the planned live streaming of class X. The announcement was followed by an email that was sent to the target audience 4 days before data collection, inviting them to take part in this research study. It was explained that data collection for the research study would take place during a specific lecture and on a specified date. It was also explained that participation in the study would mean that they would participate by either attending class X physically (i.e. the same way as they normally would) or remotely in an electronic classroom where the same lecture would be live-streamed.

Participation in this study was voluntary and participants remained anonymous. It should be noted that class X was not only presented to participants of this study. Other students were also in attendance in the physical classroom to ensure that the 'control group' could function as it normally would.

Data design and collection

A comprehension test was developed to test the effectiveness of a live-streamed lecture. After the lecture was concluded, all participants (whether in class physically or in the electronic classroom) were asked to complete the comprehension test. The test was available for completion on paper or electronically. The comprehension test consisted of six questions. Question 1 was included for participants to confirm whether they attended the lecture physically or watched via live-streaming. Questions 2–6 were content-specific and based on the lecture. The content questions were presented with four possible answers (with the exception of question 6 which had eight possible answers). Four of the content questions were marked out of one, while the fifth content question counted two marks. The comprehension test was marked out of six. All the content questions also had a last option where participants could choose not to answer. The results of the two groups were compared to determine the extent of the difference in comprehension.

A follow-up questionnaire was also designed to obtain feedback from participants who attended class X remotely. This questionnaire was sent via email to all participants who were randomly selected to attend class X in the electronic classroom. Participants who followed the research instructions and attended class X in the electronic classroom were given three questions in the follow-up questionnaire, each time with an option of preferring not to answer. There was also an

opportunity to give comments on their experience of the class that was live-streamed. Participants who did not follow the research instructions and therefore went to physical class instead of the electronic classroom were asked what the reason was for this decision.

Statistical analysis and addressing pre-existing conditions

Primary data, being participants' results of the comprehension test, were subjected to analysis of variance (ANOVA) tests. The ANOVA tests were done on the Statistica software program to test the hypothesis that the mean scores between the groups are the same. A 5% significance level was applied to all data analysed ($p = 0.05$). Normal probability plots were checked and found to be acceptable for all data reported. Data collected from the follow-up questionnaire were analysed by the researchers.

The most recent results available to determine student performance at the time of the study were students' mid-year mark in 2017. This mark is referred to as the progress mark (PM). Participants were randomly allocated to attend class physically or via live-streaming. The PM was used as control check to ensure that the results of this study were not influenced by the pre-existing performance ability of participants. In another attempt to address possible disparity, the participants were asked to rate their own technological ability to determine whether pre-existing self-rated technological ability could influence the results.

Ethical considerations

The relevant authorities provided ethical clearance and institutional permission. The research ethics committee: humanities project number is REC-2018-0875. The institutional reference number is IRPSD 587.

Research findings

The target audience consisted of 409 first-year BAAcc students (all of whom receive instruction in English), of which 84 indicated that they would participate in the study (21%). The demographics of the target audience and the participants of this research study are presented in Table 1.

TABLE 1: Demographics and average progress mark of target audience and participants.

Category	Options	Target audience		Participants	
		Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Average progress mark	Out of 100	409	52	84	54
Gender	Female	203	50	52	62
	Male	206	50	32	38
Race	African	71	17	17	20
	Mixed race	100	24	21	25
	Indian	10	3	3	4
	White	228	56	43	51
Home language	Afrikaans	76	19	15	18
	English	275	67	57	68
	Other	58	14	12	14

The demographics and average PM of participants do not seem to differ substantially from that of the target audience, except in terms of gender. Female students were much more interested to participate in the study than male students.

The 84 participants were randomly allocated to physically attending or making use of live-streaming for class X. After the data had been collected, it was noted that 68 participants (81%) followed the instructions and attended class X in the location to which they were allocated. The results of the 84 (all the volunteers for this study irrespective of whether they attended class X in the correct location or not) and 68 (participants who attended class X in the correct location) were analysed in exactly the same manner and no statistical difference was noted for the different number of results analysed. Of the participants who live-streamed class X, three participants live-streamed from another location than the electronic classroom. The effect that these participants had on the final results was not considered material. This study therefore reports on the results of 84 participants.

The PM was used as a control check to determine whether a difference existed in PM for participants attending class physically and remotely. There was no significant difference in the PM of the participants ($p = 0.45$), and therefore we can accept that their performance ability for the subject lectured in class X is similar.

Participants were also asked to rate their technological ability from 1 (very strong technologically) to 5 (bad with technology). The average self-rated technological ability of the 84 participants was 1.73, indicating a collective response of strong technological skills. When the results were analysed separately for participants who attended class X physically and participants who live-streamed class X, it was found that participants who physically attended class X had a better self-rated technology level (1.69) than participants who live-streamed class X (1.81). This is satisfying from a methodology point of view and eliminates pre-existing technological ability (even though self-rated) as a possible influencing factor in the results of this study.

Testing the effect of a live-streamed lecture on student performance

The combined average for the comprehension test was 49%. Participants who live-streamed class X tended to perform better than participants who attended class X physically with $p = 0.05$. The effect of the PM was removed by means of an ANOVA co-variance test. A result of $p = 0.07$ was reported, indicating that the difference in the results of the comprehension test is not dependent on the PM. This result supports the finding that the two groups' ability in accounting is similar and that their ability is not the determining factor in the difference in results of the comprehension test between the locations. A summary of the results is presented in Table 2.

The results were further analysed based on the demographics of the participants by means of co-variance ANOVA tests.

TABLE 2: Summary of results.

Variable	No. of participants (%)	Mean (%)	Standard deviation	F	F (p-value)
Progress mark (out of 100)					
Physical class	52 (62)	52.91 (53)	13.50	0.58	0.45
Live-streamed	32 (38)	55.12 (55)	11.86		
Comprehension test mark (out of 6)					
Physical class	52 (62)	2.71 (45)	1.29	3.90	0.05
Live-streamed	32 (38)	3.25 (54)	1.08		

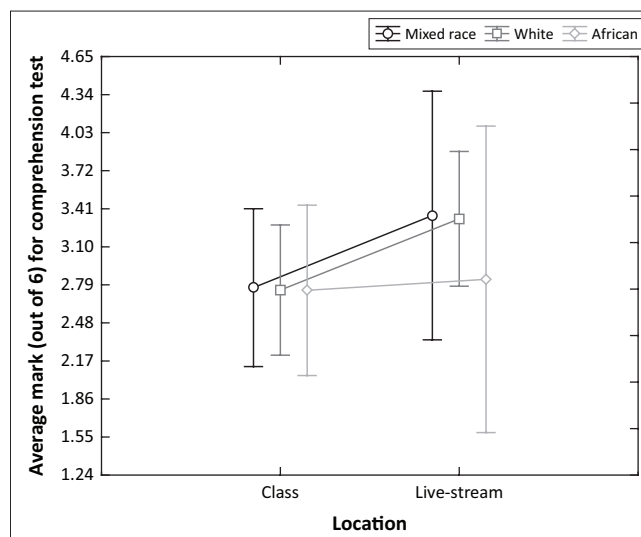
TABLE 3: Results of comprehension test per participant demographic and between the two locations.

Category	Options	No. of participants		Average % for comprehension test	
		Attended class physically	Live-streamed class X	Attended class physically	Live-streamed class X
Gender	Female	29	23	48	57
	Male	23	9	42	46
Race	African	13	4	46	47
	Mixed race	15	6	46	56
	Indian	2	1	33	33
	White	22	21	46	55
Home language	Afrikaans	10	5	50	63
	English	34	23	44	54
	Other	8	4	44	42

Because of the small numbers for home language, no further analysis was performed on those results. Results are therefore only reported for gender and race groups. Even though a trend was identified ($p = 0.10$) that female participants (52%) perform better than male participants (44%) overall, the interaction showed that gender is not a determining factor in the difference in performance between participants in class and participants who live-streamed class X ($p = 0.74$). This finding corresponds with the findings of Carrick et al. (2017), who reported similar performance for female and male students for lectures that have been live-streamed. A detailed summary of the results between the locations and per demographic profile is presented in Table 3.

In analysing the results for race, Indian participants were excluded, as only three participants from this race group took part in the study. No significant difference was reported between any of the other race groups overall (African participants averaged 47%; mixed race participants 51% and white participants 51%). This might be as a result of the fairly small number of participants spread over three race groups and two locations. Having said this, it was still interesting to note that African participants' performance was very similar between the two locations, whereas participants from the mixed race and white race groups performed better in the live-streaming location. This study cannot report on the reason for this finding and encourages further research on this matter (see Figure 1).

Another interesting finding related to the race of participants was that participants from the African and mixed race groups were not evenly spread between the two locations. Participants from these race groups seem to prefer physical class attendance, where 76% of African participants and 71%



$F(2.74) = 0.199$; $p = 0.82$.

Note: Vertical bars denote 0.95 confidence intervals.

FIGURE 1: Results per race group.

of mixed race participants attended class physically. Upon further investigation it was noted that 8 out of 13 (62%) participants, who were allocated to live-stream class X and decided not to follow these instructions (i.e. attended class physically) were from either the African or mixed race group. This observation corresponds with Sader and Gabela (2017), who underlined the insecurities of students from disadvantaged backgrounds with the use of technology.

Research question 1 aimed to determine the effect of a live-streamed lecture on student performance. The findings of this study show a strong trend that students perform better in the live-streamed lecture than in physical class. This suggests that a live-streamed lecture, as an *ad hoc* alternative to physical class attendance for accounting students, could uphold student performance and aid the continuance of the syllabus at times of class disruptions. Given the fact that pre-existing ability in accounting as a subject and technological ability is not an influencing factor in the results, the researchers can only hint as to a possible explanation for the finding. The fact that participants who live-streamed the lecture could focus solely on listening and watching the lecture, with no distractions from other classmates or possibly their cell phone, might have influenced them to perform better in the comprehension test.

Students' experience of the live-streamed lecture

A follow-up questionnaire was sent to 41 participants who were randomly allocated to attend the live-streamed class X. Only 32 of these participants followed the research instructions and attended the class from the electronic classroom. The questionnaire was completed by 24 participants (59%). Six of the 24 participants who completed the questionnaire did not follow the research instructions. The majority of these participants' feedback indicated that they did not think it was important whether they attend class physically or via live-streaming.

Participants who followed instructions and attended the live-streamed lecture were asked, based on the results of Rossouw (2018), whether they focused better when they attended the live-streamed lecture than they normally do in the class. Of the 18 participants, 11 (61%) stated that they focused better. In light of the high ranking that focus received as an argument in favour of live-streaming in Rossouw's study (listed as reason number 2 out of eight), it is curious to note that only 61% of students actually found live-streaming to help them focus better. It is even more curious considering the fact that participants who attended the live-streamed lecture performed better than those who attended class X physically. This question in particular only gave participants the option of choosing 'yes' or 'no', and therefore 39% of participants did not state that they focused better than they normally would in the class. This finding supports the notion that students would still prefer physical lectures (Bennet & Glover 2008; Hills et al. 2017).

Class X was considered to be a controlled environment and without any disruptions (whether technical or otherwise). If live streaming was to be implemented, students would attend live-streamed lectures from locations that are not necessarily equipped or sufficient to support live-streaming facilities or learning. The next question in the questionnaire therefore asked whether participants thought that they would focus just as well at their own home, flat or residence as they did while in the controlled electronic classroom. Interestingly enough, 15 out of the 18 participants (83%) stated that they would focus just as well in other environments as in the controlled electronic classroom. It should, however, be noted that this feedback is provided on the basis of one live-streamed lecture. The risk still exists that students might feel detached from the learning environment and hence might waiver in their level of focus if they were to make use of live-streaming more often, or in isolation without any physical class contact, as was the finding of Fredriksen (2015).

Given the fact that this study shows a trend for better performance when live-streaming a lecture, participants were also asked whether they think that they would perform better if they streamed all of their lectures. The majority of respondents (56%) indicated that live-streaming might lead to better results and did not want to commit by answering 'yes' or 'no' with certainty.

Participants made the following comments on the follow-up questionnaire:

'It was a great experience and I thought that with the right mindset and discipline students could benefit from this method of teaching'. (Participant 73, female, black, 18 years old)

'I think this is a great initiative and something that I could definitely see myself using in the future'. (Participant 4, male, white, 20 years old)

'Would love to have the live streaming as an additional option'. (Participant 50, female, white, 19 years old)

It is clear from the additional comments that participants who have used the live-streaming facility are positive about the

concept and eager to make use of this option. Their reaction answers research question 2, which set out to get feedback from students' experience of the live-streamed lecture.

Conclusion

It is evident from the literature review conducted and from sheer logic that student performance at tertiary institutions is imperative. If, for any reason, student performance is in jeopardy, alternatives should be available to ensure that learning can continue undisturbed. Live-streaming provides an alternative to physical class attendance, especially at times when situations prohibit class attendance. The question, however, is whether live-streaming would be effective in terms of student performance when done as an *ad hoc* replacement of physical classes. The objective of this research was to test the effectiveness of live-streaming by doing a randomised control trial.

First-year BAcc students who receive instruction in English were invited to take part in the study. Participants were randomly allocated to either attend class physically as they normally would (control group) or to attend the same lecture remotely by attending the live-streamed lecture from a controlled electronic classroom. After the lecturer concluded the lesson, participants were asked to complete a comprehension test that contained five content-specific questions based on the lecture that they just attended. An ANOVA test was performed and a strong trend was identified: participants who made use of live-streaming performed better than participants who attended the lecture physically. This finding answered research question 1, which aimed to test the effect of a live-streamed lecture on student performance. The effect of participants' pre-existing performance ability, which was determined by means of their performance mark for the subject that was lectured, was removed through an ANOVA co-variance test and confirmed that the difference in results of the comprehension test is not reliant on participants' pre-existing performance abilities in accounting as subject. Furthermore, pre-existing self-rated technological ability was also eliminated as a factor that could have influenced the result.

Results were also analysed for participants' demographic profiles. Even though there were no significant differences between the different race groups, it was still interesting to note that African participants' performance was very similar between the two locations, whereas participants from the mixed race and white race groups performed better in the controlled electronic classroom than participants who attended the lecture physically. Female participants performed better than male students overall. However, gender was not considered to be a determining factor in the performance between participants who attended the lecture physically and those who live-streamed.

A follow-up questionnaire was sent to participants who were randomly selected to attend the live-streamed lecture. The majority of these participants stated that they focused better

with the live-streaming facility. Participants also stated that they would focus just as well if they were to live-stream from their own home, flat or residence as from the controlled environment that was created specifically for this research study. Even though the results of this study show a trend for much better performance when attending a live-streamed class than physically attending it, the participants indicated that they were unsure whether live-streaming would lead to better performance if this was applied to all their lectures. Lastly, research question 2, which aimed to determine students' experience of the live-streamed lecture, was answered by participants' comments from their experience. It was clear that participants who live-streamed the lecture thoroughly enjoyed the experience and would make use of this facility again.

This study shows that the use of live-streaming facilities as an alternative to physical class attendance will not necessarily be detrimental to student performance. In fact, live-streaming could enhance student performance when used on an *ad hoc* basis. This should be a welcome finding for tertiary institutions that are in need of alternatives to their existing modes of learning; such alternatives are necessitated by factors that impact student performance and that are beyond their control.

Higher education institutions could consider providing students with the necessary technology for live-streaming of classes when they register to ensure that all students have access to the technology if and when needed.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

Both authors worked on the final manuscript. S.S. focused on the literature review, while M.R. focused on analysis of the data.

References

Abdous, M. & Yen, C., 2010, 'A predictive study of learner satisfaction and outcomes in face-to-face, satellite broadcast, and live video-streaming learning environments', *The Internet and Higher Education* 13(4), 248–257. <https://doi.org/10.1016/j.iheduc.2010.04.005>

- Bennet, P. & Glover, P., 2008, 'Video streaming: Implementation and evaluation in an undergraduate nursing program', *Nurse Education Today* 28(2), 253–258. <https://doi.org/10.1016/j.nedt.2007.04.005>
- Carrick, F.R., Abdulrahman, M., Hankir, A., Zayaruzny, M., Najem, K., Lungchukiet, P. et al., 2017, 'Randomized controlled study of a remote flipped classroom neuro-otology curriculum', *Frontiers in Neurology* 8(1), Article 349. <https://doi.org/10.3389/fneur.2017.00349>
- De Lange, R., Marx, B. & Van der Watt, A., 2013, 'Sustainability in education: An evaluation of a new teaching and learning strategy in chartered accountancy studies – A student perspective', *Journal of Economic and Financial Sciences* 6(2), 285–308.
- Department of Higher Education and Training (DHET), 2017, *2000 to 2014 First time entering undergraduate cohort studies for public higher education institutions*, viewed 23 March 2018, from [http://www.dhet.gov.za/HEMIS/2000%20TO%202014%20FIRST%20TIME%20ENTERING%20UNDERGRADUATE%20COHORT%20STUDIES%20FOR%20PUBLIC%20HEIs%20\(final\).pdf](http://www.dhet.gov.za/HEMIS/2000%20TO%202014%20FIRST%20TIME%20ENTERING%20UNDERGRADUATE%20COHORT%20STUDIES%20FOR%20PUBLIC%20HEIs%20(final).pdf)
- Fredriksen, H., 2015, 'A case study of an experiment using streaming of lectures in teaching engineering mathematics', *Teaching Mathematics and Its Applications* 34(1), 44–52. <https://doi.org/10.1093/teamat/hru029>
- Frintd, T., 2007, 'The impact of video conferencing on distance education courses: A university of Namibia case study', *Progressio* 29(1–2), 56–68.
- Gerber, C., Mans-Kemp, N. & Schlechter, A., 2013, 'Investigating the moderating effect of student engagement on academic performance', *Acta Academica* 45(4), 256–274.
- Gezgin, D.M., Adnan, M. & Acar Guvendir, M., 2018, 'Mobile learning according to students of computer engineering and computer education: A comparison of attitudes', *Turkish Online Journal of Distance Education* 19(1), 4–17. <https://doi.org/10.17718/tojde.382653>
- Henderson, M., Selwyn, N. & Aston, R., 2017, 'What works and why? Student perceptions of "useful" digital technology in university teaching and learning', *Studies in Higher Education* 42(8), 1567–1579. <https://doi.org/10.1080/03075079.2015.1007946>
- Hills, C., Boshoff, K., Gilbert-Hunt, S., Ryan, S. & Smith, D.R., 2015, 'Practice educators on the strengths and challenges of "Generation Y" occupational therapy students', *The Open Journal of Occupational Therapy* 3(4), Article 6.
- Hills, C., Levett-Jones, T., Lapkin, S. & Warren-Forward, H., 2017, 'Generation Y health professional students' preferred teaching and learning approaches: A systematic review', *The Open Journal of Occupational Therapy* 5(1), Article 12.
- Hodes, R., 2016, 'Questioning "fees must fall"', *African Affairs* 116(462), 140–150. <https://doi.org/10.1093/afraf/adw072>
- Jackson, L.A., Zhao, Y., Kolenic III, A., Fitzgerald, H.E., Harold, R. & Von Eye, A., 2008, 'Race, gender, and information technology use: The new digital divide', *Cyberpsychology & Behaviour* 11(4), 437–442. <https://doi.org/10.1089/cpb.2007.0157>
- Jordaan, Y., 2009, 'Influencing factors on lecture attendance at a tertiary institution', *South African Journal of Higher Education* 23(1), 98–112. <https://doi.org/10.4314/sajhe.v23i1.44805>
- Kahu, E.R. & Nelson, K., 2018, 'Student engagement in the educational interface: Understanding the mechanisms of student success', *Higher Education Research & Development* 37(1), 58–71. <https://doi.org/10.1080/07294360.2017.1344197>
- Lai, K. & Hong, K., 2015, 'Technology use and learning characteristics of students in higher education: Do generational differences exist?', *British Journal of Educational Technology* 46(4), 725–738. <https://doi.org/10.1111/bjet.12161>
- Mann, C.J., 2003, 'Observational research methods. Research design II: Cohort, cross sectional, and case-control studies', *Emergency Medicine Journal* 20(1), 54–60. <https://doi.org/10.1136/emj.20.1.54>
- Owens, J., Hardcastle, L. & Richardson, B., 2009, 'Learning from a distance: The experience of remote students', *Journal of Distance Education* 23(3), 53–74.
- Rossouw, M., 2018, 'The perceptions of students and lecturers on the live streaming of lectures as an alternative to attending class', *South African Journal of Higher Education* 32(5), 253–269.
- Sader, S.B. & Gabela, N.P., 2017, 'Spatialities of widening participation: Narratives of first year students receiving financial aid', *South African Journal of Higher Education* 31(1), 227–242. <https://doi.org/10.20853/31-1-1056>
- Smit, S. & Steenkamp, G., 2015, 'The competencies developed in an undergraduate Accounting course before SAICA's competency framework was effective: A student's perspective', *Journal of Economic and Financial Sciences* 8(2), 666–688.
- Strauss-Keevy, M., 2014, 'Education programmes' responsibilities regarding pervasive skills', *Journal of Economic and Financial Sciences* 7(2), 415–432.
- Van Schalkwyk, S., Menkveld, H. & Ruiters, J., 2010, 'What's the story with class attendance? First-year students: Statistics and perspectives', *South African Journal of Higher Education* 24(4), 630–645.
- Yang, Z. & Liu, Q., 2007, 'Research and development of web-based virtual online classroom', *Computers & Education* 48(1), 171–184. <https://doi.org/10.1016/j.compedu.2004.12.007>
- Weiler, A., 2004, 'Information-seeking behavior in generation Y students: Motivation, critical thinking, and learning theory', *The Journal of Academic Librarianship* 31(1), 46–53. <https://doi.org/10.1016/j.acalib.2004.09.009>