



Online Quizzes as Mediating Tools for Teaching Information Communication Technology to First Year Students at a College of Education in the Developing Context of Lesotho

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Abstract. In this study we investigate how the use of online quizzes can mediate students' acquisition of scientific concepts within the zone of proximal development (ZPD). We draw on the work of Vygotsky (1978) in our conception of pedagogy as mediated, or guided, by a culturally more competent other in a uniquely developmental social space that he terms the ZPD. This space is opened in a pedagogical setting where a novice is mediated into acquiring abstract, or scientific concepts. The use of online tools in teaching in Higher Education is gaining in relevance due to the isolating effects of the covid pandemic. Three hundred and sixty first year students, enrolled for the Diploma in Secondary Education, studying Computer Awareness and Skills were given access to three online quizzes every three weeks alongside instruction. Seventy students completed all 3 quizzes. These mediated quizzes provided the lecturer with knowledge about what students knew and what they needed to know, providing access to students' ZPD. Findings indicate that 1) use of the quizzes leads to statistically significant increase in marks over time, 2) that students who wrote all three quizzes outperformed their peers who did not write the quizzes on the final semester paper and pen test and 3) that students felt that the quizzes motivated them to learn. We conclude that ICTs, in the form of online, mediated quizzes can mediate acquisition of knowledge in a tertiary setting.

Keywords: Computer Awareness, Mediation, Quizzes, Mediation, Zone of Proximal Development (ZPD)

1. Introduction

In the 21st century, Information Communication Technologies (ICTs) have become ubiquitous. They are used by young children and adults alike. However, there is still a debate in educational settings about the impact that ICTs can have on developing students' cognition (Hardman; 2019). While there is a substantial body of knowledge regarding the impact that ICTs have on attainment in primary school (Tamim, Bernard, Borokhovski, Abrami and Schmid, 2011; Higgins, Xiao, Katsipataki, 2012; Li & Ma, 2010; Cheung & Slavin, 2013; Demir & Basol, 2014; Xie, Wang, Hu, 2018, Chuahan, 2017; Slavin, Lake & Groff, 2009; Slavin & Lake, 2008; Rakes et al, 2010) there is considerably less published research indicating the impact that ICTs can have at a tertiary level. However, especially during the pandemic, ICTs have become necessary in

higher education and therefore, it is important to study the impact they have on students' learning (Johnson, Adams Becker, Cummins, Estrada, Freeman & Hall, 2016). One clear finding from the literature is that it is not ICTs themselves that impact positively on outcomes but, rather, how they are used pedagogically (Hardman, 2019, 2019; Webb & Cox 2004). In this paper, we locate our work theoretically in the pedagogical developments that arise from cultural historical theory as articulated by Vygotsky (1978; 1987; 1986). This paper seeks to address the following question:

Can an online quiz mediate attainment in students in a teaching college in Lesotho?

1.1 Context

This study is located in a teacher education college in Lesotho, which trains primary school teachers and junior secondary teachers at both pre-service and in-service training levels (The Ministry of Education and Training on the Education Sector Strategic Plan 2005-2015, 2005). It offers Diploma Certificates, and the duration of the program is three years for pre-service student teachers. The college has two campuses; the main campus is in Maseru and the other one is in the Thaba-Tseka District. All first-year students in pre-service training level are required to take the module Computer Awareness and Skills. This is an introductory course run at both campuses.

Lesotho is a land locked, small mountain kingdom, ruled by a monarch. While a separate kingdom, Lesotho is in fact, located within South African borders. The population stands at 2.13 million people, making it one of the smallest populations in Africa. It is a developing country with many challenges, not least of which is poverty. Lesotho's GDP is 1.5 Billion USD as compared to South Africa's GDP of 349.4 billion USD, in which Lesotho is located, although it is an independent kingdom. South Africa's GDP is considerably higher than Lesotho's as the population in South Africa stands at 60 041 994. Due to financial and infrastructure challenges, technology roll out in Lesotho lags significantly behind what one sees in South Africa. In 2005 the Government undertook to establish the Information and Communications Technology (ICT) requirements for each institution of higher learning and facilitate the acquisition of the needed hardware, software and training requisites (The Ministry of Education and Training on the Education Sector Strategic Plan 2005-2015, 2005). However, to date this policy has not been implemented. Lack of access to ICTs in schools means that many, if not most, pre-service teachers embarking on their tertiary studies are not proficient in using ICTs outside of mobile telephony.

Approximately seven hundred first-year students take the course "Computer Awareness and Skills" during the first semester (January to June) at the Maseru campus. There are only two lecturers to facilitate the course. Dealing with large classes is one of the challenges facing the two instructors. A second challenge lies in the relative lack of resources as there are only two computer laboratories with 30 computers in each, for 700 students. The lack of resources, both human and technical, require that the two lecturers teach sixteen different groups of students per week, which is incredibly labour intensive. Each lecturer teaches 8 groups per week and each group contains an average of 45 students. Moreover, marking tests and quizzes takes up a large amount of the lecturers' time. Further, the heavy load of marking means that lecturers are unable to engage in detailed feedback when marking, making it very difficult for students to track their progress or indeed, to better their trajectory based on detailed feedback. The large student numbers coupled with human resource shortages, have led to the desire to harness technology to facilitate learning/teaching.

1.2 Theoretical Framework

‘The Russian word *obuchenie* does not admit to a direct English translation. It means both teaching and learning, both sides of the two-way process, and is therefore well suited to a dialectical view of a phenomenon made up of mutually interpenetrating opposites’ (Sutton, 1980:169–170, in Mahn, 2013)

Drawing on the work of the Russian psychologist Vygotsky (1978; 1987; 1986) we conceive of teaching/learning as dialectically entailed. There can be no teaching without learning nor learning without teaching. We understand pedagogy as a dialogical relationship between teacher and taught; this moves away from the Behaviourist notion of a student as a blank slate to a conception of a student as an active cognising agent, who works with a more competent other to develop cognitively. Vygotsky argued that teaching/learning happens through a process of mediation, where a culturally more competent other, the teacher, guides a novice into novel ways of knowing. This is carried out in a uniquely social space that he terms the zone of proximal development (ZPD). He describes the zone of proximal development (ZPD) as:

... the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers... the actual developmental level characterises mental development retrospectively, while the zone of proximal development characterises mental development prospectively. (Vygotsky, 1978: 86-87)

It is within this zone, that true learning can happen, and it is here that learning can lead to cognitive development. The development of higher cognitive functions, those uniquely human functions such as language and mathematics for example, happen in the ZPD through the acquisition of what Vygotsky (1986) calls scientific concepts. It is important to note that these concepts do not relate in a narrow sense to science as a field of knowledge, but rather, more expansively to any abstract concept that must be taught. For Vygotsky:

The development of the scientific... concept, a phenomenon that occurs as part of the educational process, constitutes a unique form of systematic co-operation between the teacher and the child. The maturation of the child's higher mental functions occurs in this co-operative process, that is, occurs through the adult's assistance and participation. ... In a problem involving scientific concepts, he must be able to do in collaboration with the teacher something that he has never done spontaneously... we know that the child can do more in collaboration than he can do independently. (Vygotsky, 1987: 168)

This quote highlights the fact that scientific concepts are necessarily taught and, moreover, they are taught through mediation in the ZPD. In our paper, then, we can understand the computer concepts taught in the lectures as scientific concepts. Vygotsky makes a distinction between these abstract concepts that must be taught, and spontaneous, everyday concepts that are learnt through empirical engagement with the world. It is important to note that scientific and everyday concepts are dialectically entailed; one cannot learn abstraction in the absence of a meaningful context in which to situate this, similarly everyday concepts only come to conscious awareness through linking them to scientific concepts. Much research to date has indicated that Vygotsky's work is empirically sound in relation to learning/teaching in schools (Wood, Bruner and Ross, 1976; Gallimore and Tharp, 1993; Hedegaard, 2002; 2005; 2009; Mercer, 2000a; 2000b; Cazden, 1986; 2001; Wells, 1999). Drawing on Vygotsky's theory, then, we are able to define pedagogy as:

a structured process whereby a culturally more experienced peer or teacher uses cultural tools to mediate or guide a novice into established, relatively stable ways of knowing and being within a particular, institutional context in such a way that the knowledge and skills the novice acquires lead to relatively lasting changes in the novice's behaviour, that is, learning (Hardman, 2008: 69).

What this definition of pedagogy highlights is that learning is a mediated process where an expert enables the novice to gain access to new knowledge through active engagement.

1.3 Rationale: the case for focusing on questioning

Questioning is one of the basic techniques used to enquire about and generate understanding of one's surroundings; it is also a means with which to regulate behaviour. When faced with something unfamiliar, something that 'doesn't fit' with his/her current knowledge, the resultant feeling of 'perplexity' enables the student to ask questions, to add to his/her knowledge; to learn (Dillon, 1988). The student's question demonstrates that his/her current experiential framework is not adequate for solving a problem, providing the teacher with a view of the present state of the student's knowledge, pointing to what he/she needs to know, or be taught. The posed question, then, provides the perfect opportunity for teaching in that it shows the teacher what the student knows and what s/he needs to know to solve a particular problem. By highlighting the gap between what the student knows and what the student needs to know, questions provide unique access to the student's Zone of Proximal Development (ZPD), directing the teacher towards specific interventions. Questioning, then, is a very useful indicator of what assistance the student needs. As such, it is a useful learning-teaching tool for the teacher. So, the student's question does more than simply point to what s/he needs to learn; it directs the teacher's interventions, pointing to areas that need external regulation. The student's question, then, is not only a useful pedagogical indicator of the student's knowledge base; it is also a cognitive tool, capable of regulating mental actions. Self-regulation (metacognition) requires an ability to question one's own actions, to ascertain which are effective strategies for doing certain things and which are not. Problem solving, then, requires the ability to interrogate our own actions, to ask questions (Strohm-Kitchener, 1983). A student's question provides the perfect opportunity for teaching by setting the student and teacher on the same path, towards learning. Similarly, a lecturer's question highlights what the students' needs to learn, selecting specific content for the student to engage with. Our focus on designing online quizzes that take the form of closed questions, was informed by the notion that a question can 1) provide access to the students' ZPD and 2) can serve to scaffold a student's engagement with knowledge acquisition (Hardman, 2019). Even a closed question, which does not provoke discussion, can be used to open engagement depending on how it is used (Hardman, 2008). If closed questions are used in a scaffolded manner to enable the student to move from simpler to progressively more difficult levels of abstraction, this can lead to learning.

1.4 The context for mediation: the online quiz

In a bid to 1) alleviate the large amount of marking, 2) provide detailed feedback to students to inform their development and 3) mediate student engagement with the course material thereby impacting their outcomes on a test, we designed 3 online quizzes using Google forms and Flubaroo as an online grading tool. We placed a link to the quiz on a Facebook page that has been used by the college for informal teaching and learning for the past two years. One of the benefits the lecturers and students derived from these online quizzes, we hypothesised, was the instant feedback they would receive once they

had completed the quiz. For lecturers, this instant feedback enables the lecturer to know what the student knows and what they still need to learn, enabling the lecturer to tailor the course to these needs. For the student, instant feedback illustrates where they need to improve in a timely fashion. Research by Justin and Joseph (2016), indicates that this timeous response is appreciated by students. Further, we designed the quizzes in such a manner that they mediated, or guided, students' engagement with the content being studied. For example, questions could be as simple as basic factual questions such as "What is the function of the save button" to more complex questions procedural questions, such as "how would you save a document in word"

2. Methodology

2.1 The online context

At the beginning of the semester, Thato Ntlhoi, who is both researcher and lecturer on this course, provided students with access to the Facebook class group. Three online quizzes were made available to the 360 Diploma in Education for Secondary (DES) students but engaging with them was not compulsory. The logic underpinning the multiple use of quizzes was informed by the understanding that "repeated practice of concepts would be difficult, if not impossible, during class time, particularly with conventional assessment" (DeSouza & Fleming, 2003, p. 11). The marks obtained on the quizzes did not contribute to the coursework since the quizzes were solely used for mediating students' acquisition of scientific concepts. The links to the quizzes, covering taught topics or concepts, were posted on the Facebook group every three weeks. DeSouza and Fleming (2003) suggest that "...asynchronous learning, like homework or a take-home examination, allows students to look up material in their textbook as well as work in groups" (p. 3). Students were able to respond to the quizzes in their own time when they did not feel pressured by work. To investigate the impact quizzes had on their learning, a traditional test was administered, and it contributed to their coursework marks. The online questions were designed as multiple choice and closed questions. The rationale for the closed questions was to structure the questions in such a manner that they worked from the simple to more complex, effectively bridging the gap between what students knew and could do and what they needed to know. That is, the questions were structured to operate in the students' ZPD. While cloze questions may not appear to be mediating tools, research (Hardman, 2008) has shown that where knowledge bases are very low, cloze type questions can indeed mediate conceptual development.

2.2 Participants

Two lecturers were assigned to teach this course and 360 students were registered for this course. Lecturer 1 is a male, 37 years old, with a BSc. in Computer Science and Statistics from the University of Lesotho. Lecturer 2, the co-author of this paper, is a 31-year-old female with a BSc in Computer Science and Statistics (University of Lesotho), a PDGE in Mathematics and a PGDip in ICTs (University of Cape Town). While 360 students were registered for this course, only 70 students completed all three quizzes. In this paper we compare the outcome, on a final pen and paper test, of these 70 with students in the class, to ascertain whether the quizzes had any positive outcomes on their performance. Ethical clearance was obtained from our institution and permission to undertake the research was given by the participating institution. One of the paper's authors was a lecturer on this course and we recognise that this asymmetrical power relationship could well have impacted on students' willingness to engage with the quizzes. We note, however, that of the 360 students registered for this course, only 70 elected to engage with the quiz, which is perhaps suggestive of the fact that students did not feel obligated to do this work.

2.3 Analysis

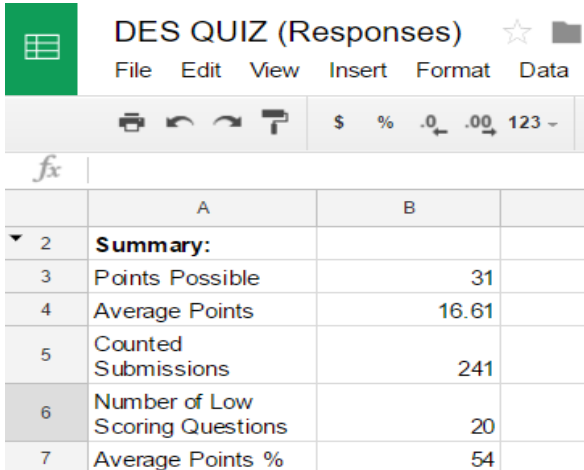
We note here that access to technology and wifi or data is unpredictable in Lesotho. However, it is of interest to note that 1.58 million people in Lesotho use smart phones (the Global Economy.com). Hence, the participants in our study used their mobile phones to engage with the quizzes. Data were captured by Flubaroo in quantitative percentages scored on items in the quiz. We ran a two-tailed t-test to compare performance on quiz 1 against final performances on quiz 3. Only the 70 students who completed all the quizzes formed part of this statistical test. Secondly, we used excel to run a t-test to compare performance on the final paper and pen traditional test for the 70 students who had engaged with all three quizzes and a randomly sampled group of 70 students who had not engaged with the quizzes but who were members of the same cohort and class. Qualitative data from Facebook questions regarding students' perceptions of the quizzes as learning tools were analysed thematically. This paper is concerned more with the statistical analysis of performance than the thematic analysis of students' responses to the technology.

3. Findings and discussion

3.1 Results of DES online quiz

What we can see in table 1 is that the average percentage obtained was 54% in the first quiz. This is a low mark and barely representative of a pass mark. In table 2, we can see that the number of low scoring questions has dropped from 20 to 6; however, the average percentage has also dropped to 53%. In table 3 we can see a marked improvement in the average points scored, with the mean moving from 53% to 79%. To determine whether this is statistically significant we ran a t-test in excel.

Table 1 below shows DES quiz 1 summary results.



	A	B	C
2	Summary:		
3	Points Possible	31	
4	Average Points	16.61	
5	Counted Submissions	241	
6	Number of Low Scoring Questions	20	
7	Average Points %	54	

Table 2 below shows DES quiz 2 summary results.

	A	B	C
2	Summary:		
3	Points Possible	15	
4	Average Points	8.01	
5	Counted Submissions	233	
6	Number of Low Scoring Questions	6	
7	Average Points %	53	

Table 3 below shows DES quiz 3 summary results.

	A	B	
2	Summary:		
3	Points Possible	36	
4	Average Points	28.47	
5	Counted Submissions	70	
6	Number of Low Scoring Questions	5	
7	Average Points %	79	

Table 4: t-test: comparison of performance from quiz 1 to quiz 3

	<i>Quizz1</i>	<i>Quizz3</i>
Mean	0,437241	0,777286
Variance	0,027221	0,014956
Observations	29	70
Pooled Variance	0,018497	
Hypothesized Mean Difference	0	
df	97	
t Stat	-11,3219	
P(T<=t) one-tail	9,67E-20	
t Critical one-tail	1,660715	
P(T<=t) two-tail	1,93E-19	
t Critical two-tail	1,984723	

A t-test comparison between quiz 1 performance and quiz 3 indicated a statistically significant improvement in performance ($p=1.93 \times 10^{-19}$). The quizzes, therefore facilitated a better engagement with content knowledge over time in a group of 70 individual students who took all three quizzes. The question now becomes: What impact

do the quizzes have on those 70 individuals' paper and pen test when compared to 70 randomly selected students who did not write any of the 3 quizzes? That is, does taking the quiz enable you to outperform someone who does not take the quiz? A t-test was run between the paper and pen results of the 70 students who took the three quizzes and compared with the marks of 70 students who did not take the test. Table 5 below represents the findings.

Table 5: comparison on final test between those students who took all three quizzes and those who did not take any of the quizzes.

	<i>Variable 1</i>	<i>Variable 2</i>
Mean	0,581034	0,785286
Variance	0,011531	0,011373
Observations	29	70
Pooled Variance	0,011419	
Hypothesized Mean Difference	0	
df	97	
t Stat	-8,6554	
P(T<=t) one-tail	5,33E-14	
t Critical one-tail	1,660715	
P(T<=t) two-tail	1,07E-13	
t Critical two-tail	1,984723	

In table 5 one can see that p is significant at the 0.05 range ($p=1.07 \times 10^{-13}$). This indicates, therefore, that those people who took the quizzes outperformed those students who did not take any of the quizzes in the final paper and pen test. We turn now to investigate students' qualitative feedback regarding the online quizzes.

3.1 Facebook comments

We received 54 responses on Facebook to the questions posed regarding whether students thought the online quizzes were useful for learning the content covered in the course. Most respondents indicated that they found the quizzes useful. The extracts below are illustrative of the type of feedback we received:

Extract 1: The quiz was motivating and useful.

Student 1:

I would really advise you to use those [online quizzes] in the next semester, I would also like to share how I felt about them. I felt mature, I felt grown, I felt a College type, I was showing my mum the quiz we wrote using our smart phones, she went like "really, did you write with this"? She was very amazed. That made me feel that I'm in the world of technology fully, if I use it to write a quiz.

Student 2:

In reality, that utilized method was not only helpful but also enthusiastic as well. Even those who did not have smart phones were obliged to have one, thank you for a clever plan.

Student 3:

Lesotho is now technologically growing. They were actually helpful, sometimes one question made us learn 10 concepts.

Student 4:

We appreciate a lot to have a simplified way of learning, online quizzes indeed helped us, they equipped us to be more computer literate than we were before and our age mates do not know the things we know.

Student 5:

They really helped me a lot. I could do a lot more because of these quizzes. ... I also felt motivated to do more.

Student 6:

What made them to be so fascinating was it was my first time to use them. Since the phones are with us all the time it proved to be the most effective strategy. Books are boring and I liked this teaching strategy.

Student 7;

I have used online quizzes in my third year and found them to be very effective because it helped us to cover those things that we can't deal with in class. Also it was good since there were corrections to each question so it became easier for us to revise for exams. Feedback was given with immediate effective, one got motivation immediately or to pull up your socks when the work was done recently. ... time management skills were improved because if quiz was to be written 6-6h30pm that was that. No room for excuses. It trained us to be fast in the exam room.

What we can see from these qualitative quotes is an apparent growth in motivation to engage in the work expressed by students. Most felt that they benefitted from the quizzes and that it helped them to learn more, because they could use it outside the classroom. Immediacy of feedback was experienced as a useful learning tool and student 7 goes on to say that engaging with the quizzes equipped her to complete the examination. What we can see is that students' responses regarding the use of the quizzes were positive. We received no negative comments although one student indicated "I don't remember anything".

Data presented in this paper indicate that using a series of well-structured quizzes to enable students to gain access to content-based knowledge is useful. We argue that questions, both the asking of them and the answering of them, provides the teacher/lecturer with access to students' knowledge base: what Vygotsky (1978) calls the ZPD. It is in this uniquely social space that students can be guided from novice to expert provided they receive the structured guidance required. Our quizzes were designed to be underpinned with the notion of mediation. This theoretical framework acknowledges that an individual can perform better with assistance on problem-solving tasks than without assistance. Our findings indicate that students who engaged with all three quizzes outperformed those students who did not engage with the quizzes in the final paper and pen test of the semester. We cannot equivocally claim that it is the quiz alone that is responsible for this outcome; it is impossible in education to control for all variables that might come into play in a student's learning trajectory. One could argue that those who undertook the tests were more motivated to learn and this can in some way account for why they outperformed their peers. We would not disagree with this; however, we are also confident that making use of the quizzes gives a student a significant advantage in outperforming peers, who have not done the quizzes, in the final semester test. Learning is complex, and there is no single silver bullet that can guarantee success in Higher Education. What this paper suggests, though, is that online quizzes have the potential to enable students' to achieve more success in their work. We are not claiming that it is the quizzes alone that led to more positive outcomes in the experimental group; many variables would need to be considered to draw a causal inference. One such variable is alluded to by student 7 above, is the fact that the quizzes trained her to be faster in her exam. The questions on the exam did not duplicate questions from the quizzes, although in some instances there were some similarities. However, this similarity might also

account for the difference we see in the scores between the experimental and control groups. This is a space, then, for further research.

4. Conclusion

The paper looked at how online quizzes can help in mediating computer studies students' in acquiring scientific, schooled, concepts within their Zone of Proximal Development. Three online quizzes were administered, every three weeks, and a traditional paper and pencil test given at a later stage. Findings indicate that 1) those who took the quizzes performed statistically significantly better over time, 2) that those who engaged with all three quizzes outperformed their peers who did not engage with the quizzes on the final traditional academic test and 3) that students who took the quizzes felt that they were motivating. We conclude therefore that these structured quizzes are capable of mediating learning in this context.

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