BELIEFS OF LEARNERS AND TEACHERS IN CONTEXTS OF POVERTY REGARDING CURRICULUM-ALIGNED SCIENCE ELECTRONIC QUIZ ENGAGEMENT

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KEYWORDS: developing world education, e-Learning, information and communication technologies (ICTs), language-supportive quizzes

ABSTRACT

Electronic quizzes have the potential to extend learning time and provide rapid, personalised feedback: features known to improve learning. However, information and communication technologies (ICTs), including electronic quizzes, tend to be under-utilised in education, particularly in contexts of poverty. The Theory of Planned Behaviour (TPB) can predict ICT-uptake through measuring particular beliefs. However, little is known about such beliefs of learners, in poverty, related to software tailor-made for them. In this study, 71 grade 8 and 9 South African learners from poor rural communities, who had engaged with language-supportive curriculum-based Natural Sciences electronic quizzes over the previous three months, as well as three of their teachers, answered questionnaires designed, according to the TPB, to measure their beliefs regarding use of, and intention to continue using, this software. Positive attitudes were measured, particularly for use for revision. Support by the teacher, and the motivation of participation in an inter-school competition, were found to be important for motivating engagement. Access to computers was found to be largely gate-kept by the teachers, who perceived supervision of learners' usage as a considerable sacrifice. From these findings suggestions are made for ICT-supported interventions with learners, particularly in contexts of poverty.

Proceedings of the Australian Conference on Science and Mathematics Education, 30 September - 2 October 2020, pages 129-134, ISBN Number 978-0-9871834-9-1.

INTRODUCTION

During stress, such as caused by the current pandemic, or by the dysfunctionality characteristic of schools in contexts of poverty (Van der Berg, Spaull, Wills, Gustafsson, & Kotzé, 2016), agents other than the already over-worked teacher can be valuable to promote learning. Some information and communication technologies (ICTs), such as self-marking quizzes, have been designed to do this by extending learning time and providing rapid individualised feedback (Van der Kleij, Feskens, & Eggen, 2015). However, uptake of ICTs for learning tends to be low, particularly in the developing world (Kessy, Kaemba, & Gachoka, 2006).

PROBLEM STATEMENT

Four of the reasons Kessy et al. (2006) list for under-utilisation of ICTs in education in the developing world have to do with sourcing ICTs and are therefore nullified through donation of ICTs to schools. However, ICT presence is insufficient to promote uptake, as indicated, for example, by Gyamfi's (2017) report of a high presence of under- or even un-utilized donated computers and tablets in schools in Ghana. This is certainly the case in the 15 rural South African schools serving poor communities in which I worked as a Science mentor within a University-school partnership project, of which this study is an outcome. Each of these schools had been donated at least 20 laptops and 20 to 100 tablets and nine of the schools had at least one computer laboratory with 40 networked computers. However, at the start of the University-school partnership project, my observations and inquiries revealed that only one Mathematics teacher in one of these schools was making any use of these resources with learners. A few of the Science teachers used school laptops for administrative and teaching purposes. This low learner usage, but higher teacher usage, of ICTs within the science learning and teaching process, is consistent with Stott's (2018b) findings, in a nation-wide survey of South African Physical Sciences teachers' practises and beliefs, set within the Theory of Planned Behaviour (Ajzen, 2011). Further, that survey had revealed generally positive attitudes towards ICTs,

low expectations to use ICTs imposed on the teachers by people significant to their teaching context, such as learners, parents, the principal and department officials, and low perceptions of control over providing access to learners for hands-on-usage, despite availability of ICTs at their schools. However, to benefit from ICTs' capabilities to extend learning time and provide rapid personalised feedback, learners themselves need to be interacting with the ICTs.

In my mentorship role, I attempted to promote such interaction for learning science. I did so by attempting to support the teachers and learners in respect to two factors which Kessey et al. (2006) identified as constraining uptake in the developing world regardless of the presence of appropriate hardware: (1) a lack of software appropriate for the context and (2) limited computer literacy among both teachers and students. I did this through: (1) developing language-supportive software aligned to the local Natural Sciences curriculum, since the target population has poor language capability in English, the language of learning and teaching (Van der Berg et al., 2016), and curriculum alignment is valued highly in contexts of poverty (Guthrie, 2018); (2) loading the software on the schools' computers, showing both learners and teachers how to use these, and supporting them as they did this over a period of four years, with the present study being conducted three years into this process. The learners included in this particular study had been involved in this programme for a minimum of three months. The software consisted of match, gap-fill, multiple choice and crossword quizzes created with HotPotatoes freeware. Use of such software in this context is motivated for, and further described, in Stott (2018a).

Studies of beliefs relevant to ICT uptake in contexts of poverty in the developing world have focused on teachers' (Kriek & Stols, 2010; Stott, 2018b) and student teachers' (Gyamfi, 2017), rather than learners', beliefs. This may be related to the fact that learners in such contexts tend not to have sufficient experience with educational software to be able to develop informed beliefs (Oyedemi & Mogano, 2018). Those studies which have included learners' ICT usage within the developing world tend to focus on factors affecting the learners' access to various types of ICTs (Oyedemi & Mogano, 2018), and relationships between non-curriculum aligned ICT usage and various learning outcomes. For example, Hansen et al. (2012) found that access to laptops improved learners' abstract reasoning abilities, but did not improve their school marks. They speculated that this was because the software had not been specifically crafted to be aligned to the local curriculum. Therefore the gap in the literature which this study addresses is investigation of the informed beliefs, particularly of learners, in contexts of poverty in the developing world, regarding use of software which is specifically aligned to their curriculum and designed for their particular needs and context. To meet these criteria, the software used in this study works offline and is language-supportive and self-marking. Further, the learners had interacted with this software for a period considered sufficient to formulate informed beliefs. Although the learners' beliefs form the focus of this research, their teachers' views were also included, given the central role teachers play in the developing world context (Guthrie, 2018). As a starting point, higher achievers were focused on in this study since such learners are more likely to benefit from interventions such as this (Stott, 2019).

In light of this discussion, the following research question guides this study, in reference to a group of higher achieving grade 8 and 9 learners from poor South African communities, who were involved in the intervention programme described, as well as their teachers: What are the teachers' and learners' attitude beliefs, subjective norms and perceptions of behavioral control, relevant to use of Natural Sciences curriculum-based electronic quizzes? Each of these terms is explained below.

CONCEPTUAL FRAMEWORK

According to the Theory of Planned Behaviour (TPB), an actual behaviour is determined by a person's intention to perform the behaviour, moderated by their perception of behavioural control (PBC). Behavioural intention is determined by the person's attitude beliefs (AB), perception of subjective norms (SN) and perceived behavioural control (PBC) regarding the behaviour. In the context of learner-use of Natural Sciences electronic quizzes which learners are given for use out of school hours, as was the case in this study: (1) AB refers to the learners' and their supervising teachers' affective responses to, and beliefs concerning the consequences of, using these quizzes after school hours to contribute to the learners' learning of Natural Sciences; (2) SN includes expectations for the learners to engage with the quizzes, and for the teacher to enable this, provided by significant external sources, such as the principal, the teacher, peers, family members, and myself, for example through provision of the opportunity to participate in an inter-school competition on

condition that the quizzes are engaged in; (3) PBC is affected by the access the learners have to computers to engage with the quizzes, and the teachers' perceptions of their roles in providing this access, particularly regarding the time they have available (Mumtaz, 2000), and both their and their learners' confidence in using ICTs (Pelgrum, 2001), and technical constraints (Afshari, Bakar, Luan, Samah, & Fooi, 2009).

METHOD

RESEARCH DESIGN, SAMPLE, INTERVENTION, ETHICS AND LIMITATIONS

This is a mixed-method survey research study, guided by the Framework for Integrated Methodologies, and situated within the pragmatic paradigm (Plowright, 2011). The sample was purposively chosen as grade 8 (n = 30) and 9 (n = 41) learners from five schools in poor South African communities, chosen by their teachers as higher achievers, who had engaged with electronic quizzes to some extent, as explained below, and the teachers (n = 3) who had supervised this engagement and were available for inclusion in the data collection process. Data collection occurred at an inter-school Natural Sciences competition which I organized as part of the University-school partnership I was involved in. This competition served as the culmination of a three-month-long intervention in which the learners were expected to work for at least one hour per week on curriculum-aligned language-supportive Energy and Change quizzes which I had loaded onto their school's computers. I monitored this intervention during my weekly visits to each school, and sometimes conducted the sessions during which the learners accessed the computers. Poor South African schools are known to be dysfunctional (Van der Berg et al., 2016), and these schools were no exception. Accordingly, except in one school where learners were given three hours of access five days a week for the three months, the intervention was not as consistently conducted as intended. However, all the learners did interact with the software to some extent during this time. All participants, and the learners' parents, provided written informed consent for participation in this study, and ethical clearance for this research was obtained from the associated university. The small sample size of the teachers is an obvious limitation, as is the study's limited scope. An attempt has been made to provide as much transparency as possible, coupled with critical evaluation of the data in comparison to other studies, so as to provide readers with the insight needed to make judgements of the warrantability of the arguments, and therefore validity of the assertions made (Plowright, 2011).

DATA COLLECTION AND ANALYSIS

The questionnaires used mainly consisted of 5-point Likert-scale ratings of extent of agreement with statements regarding the three components of TPB, and of relative importance of sources of motivation and support, as shown in Table 1. Open response questions were also included for enhanced clarity and to check for consistency. The learners' and teachers' questionnaires had the same structures as one another, but the questions were modified to cater for each group's perspective. All the electronic quizzes and the questionnaires were in English. The learners answered the questionnaires during the first half-hour of the competition referred to above, with their teachers on hand to translate questions into the vernacular as required. The questionnaire responses were captured in Excel and the Likert-scale responses were analysed using descriptive statistics, guided by the research question. The patterns which were observed were then subjected to scrutiny through a search for confirming and disconfirming evidence from the open response questions.

FINDINGS AND DISCUSSION

The responses to the Likert-scale questions are summarized in Table 1. The following assertions are made in answer to the research question. The assertions are expected to apply to poor communities in developing-world contexts. Each assertion is then argued for.

- Learners and teachers who have experienced use of electronic quizzes have positive attitudes towards them, particularly for revising work which has already been taught face-to-face and where language barriers are not constraining.
- The support of a teacher and the provision of extrinsic motivation, for example through participation in a competition, enhance the likelihood of learners engaging with electronic quizzes.
- Teachers gate-keep computer access, to a large degree, and they perceive provision of computer access to learners out of school time as requiring considerable sacrifice on their parts.

Table 1 Summary of responses to Likert-scale questionnaire items

Questions, with differences between the learners' (and teachers') formats indicated	Range in which mean of Likert rating (/5) fell for learner (L) sample, n = 71 and teacher (T) sample, n = 3		
	0>3 (Disagree / Not a main factor)	3>4 (Agree slightly / A moderate factor)	4-5 (Agree strongly / A main factor)
Attitude beliefs			
The quizzes taught me (the learners) things I had never learnt (taught them) before	T	L	
The quizzes helped me (the learners) revise things I was taught (I taught them) in class			T & L
Two questions combined: The quizzes helped me (the learners) remember / understand the work			T & L
Some quizzes were frustrating (for the learners)*		L	T
The time doing (helping the learners do) the quizzes was worth it			T & L
I love computers			T & L
I love doing (letting the learners do) these quizzes			T & L
The reason why I (the learners) did these quizzes was to learn science better			T & L
The reason I (the learners) did these quizzes was to work on the computer*		L	T
Subjective norms			
I will only (get my learners to) do the next section's quizzes if there is a competition*	T & L		
I did (got my learners to do) these quizzes to be in the competition*		L	T
My friend / teacher / parent wanted me to do the quizzes	L		
Other learners supported me		L	
A teacher supported me			L
The principal supported me (I got the learners to do the quizzes because the principal wanted me to do this)	T & L		
My family supported me		L	
Perceived behavioural control			
It was easy to get a computer (for me to organize computers for the learners) to use for doing the quizzes		T	L
The English in the quizzes was easy to understand			T & L
It was easy to know how to use the quizzes			T & L
I know how to use computers			T & L
I know how to do these quizzes			T & L
I (My learners) will only be able to do the next section's quizzes if my teacher lets me (I let them) use the school computers*		T & L	
Supporting the learners doing the quizzes out of school time took a lot of sacrifice from me*			T
I had many technical difficulties with the computers*	T		

* A lower rating is preferable for these items

POSITIVE ATTITUDES TO LANGUAGE-SUPPORTIVE ELECTRONIC QUIZZES FOR REVISION

As shown in Table 1, extremely positive responses were given to most of the questions regarding attitudes towards computers and to the particular software under study and its effectiveness in promoting learning. This is inconsistent with the resistance Hunt, Thomas, and Eagle (2002) reported that students in more affluent contexts tended to express towards use of ICTs for education purposes. The few items which scored less well provide insight into constraints to this enthusiasm. Firstly, both learners and, particularly, teachers, provided more positive responses to the question about the electronic resources promoting revision of already taught work (learners: M = 4.8, SD = 0.5, teachers: M = 5.0, SD = 0.0), compared to the question about these resources promoting learning of new work not taught by a teacher (learners: M = 3.9, SD = 1.3, teachers: M = 2.0, SD = 1.4). This is despite the fact that the electronic resources included features, such as videos, designed to teach new concepts. This has some correspondence to Probyn's (2016) finding that learners in contexts of poverty tend to rely on their teacher as their sole source of information for learning science. Reading comprehension and its linked skill of listening comprehension, are requirements for engagement in self-directed learning (Lesiak & Bradley-Johnson, 1983), which includes being able to learn new knowledge from electronic resources. Stott and Beelders (2019) measured very low levels of English for science reading comprehension among approximately two-thirds of a sample of learners similar to that used in this study, suggesting limited capability to engage in self-directed learning of new concepts. The greater perception, by the teachers in this study, than the learners, that new learning is unlikely to arise from these resources, may be explainable as teachers, particularly in contexts of poverty, having

a particularly teacher-dominating concept of education (Guthrie, 2018) which may be somewhat inappropriate for the upper end of higher achievers in this context.

Stott and Beelders' (2019) study was related to the present study and used eye-tracking technology to observe how a similar sample of learners engaged with similar quizzes to those used here. Stott and Beelders (2019) found that those learners who possessed lower English for Science reading comprehension skills tended to use thinking-avoidance strategies for more text-dense and less familiar quizzes. These included guessing and random button-pressing, activities known to make for a frustrating experience (Stott & Hattingh, 2015). It is possible that this was what the participants were referring to when they agreed with the statement that some of the quizzes were frustrating. Learners' answers to the associated open-response question included reference to: (1) language difficulties: 'because it was difficult because the English was difficult and a lot' and 'they putted new words'; (2) unfamiliarity with the work: 'It is because the teacher have not teach us about it'; and (3) unfamiliarity with the technology: 'I had never experienced them in my whole entire life' (in reference to electronic quizzes). However, the agreement that some quizzes were frustrating was, on average, slight (M = 3.6, SD = 1.1). The much stronger agreement with the statement that the English used in these quizzes was easy to understand (M = 4.8, SD = 0.4) supports the argument made for their applicability within contexts of poverty, as given in Stott (2018a).

TEACHERS AND COMPETITIONS PROVIDE EFFECTIVE SUBJECTIVE NORMS

The learners indicated that their primary support for engaging with the quizzes came from their teachers (M = 4.6, SD = 0.9). The learners (M = 3.7, SD = 1.4), and particularly teachers (M = 4.0, SD = 0.8) also indicated that the motivation to participate in the competition was an important factor in encouraging use of the quizzes, although the learners generally disagreed with the statement that they would only use the next section's quizzes if a competition was held (M = 1.8, SD = 1.3). The learners strongly agreed with the statement 'The reason why I did these quizzes was to learn science better' (M = 4.8, SD = 0.6). This may suggest that competitions are only needed to initiate engagement, after which the value of the engagement to the learning process becomes the prime motivating factor for continued engagement. With some relevance to understanding the likelihood of these intentions translating into behavior, Kriek and Stols (2010) were able to predict South African physical sciences teachers' uptake of a specific ICT with a 71% accuracy using questionnaire items designed using TPB. The mismatch between intention and actual behaviour arose from limited resource access. As discussed below, teachers largely gate-keep learners' access to computers, potentially undermining the translation of the learners' intentions to actual behaviour.

TEACHERS GATE-KEEP COMPUTER ACCESS AND PERCEIVE THE SACRIFICE THIS TAKES AS BEHAVIOUR-CONTROLLING

The learners' responses to the instruction to indicate all the computer locations which they used to engage with the quizzes, reveals general dependence on use of computers at their school. Of the 67 learners who answered this question, 62 (93%) indicated they used the school computers, and 45 of these indicated that this was the only computer they had used. Although discs containing the software were given out freely to all learners, only 21 of the 71 learners in the sample reported using these, 16 of these learners using the discs within their own homes. This is consistent with the low computer access that rural South African learners are known to have (Oyedemi & Mogano, 2018). It is therefore unsurprising that both learners and teachers agreed to the statement that the learners would only be able to engage with the quizzes for the next section of work if the teacher gave them access to the school's computers. The teachers' strong agreement to the statement that supporting the learners doing the quizzes out of school time took a lot of sacrifice from them (M = 4.3, SD = 0.5), and the learners' dependence on them for computer access, suggest that a major, and probably the main, limiting factor to the learners' engagement in these quizzes is the teacher's availability to supervise access. Having anticipated this perception, I had taught the learners how to use the quizzes over a period of at least three months prior to the start of this intervention so that they could use the quizzes without the teacher's input. Further, I had suggested to the teacher that they use the computer supervision time to do their own work, or use student teachers interning at the school to provide supervision, or even provide access without supervision. It appears, however, that these suggestions were insufficient to pre-empt the teachers from forming the perception that providing their learners with access to the quizzes provided them with a considerable additional burden.

CONCLUSION

The learners in this exploratory questionnaire-based study, from a poor, developing-world context, held extremely high attitude beliefs towards using the language-supportive curriculum-based electronic quizzes provided in the intervention, particularly for revision purposes. Their control over their behaviour to use computer-based resources, however, is limited by the fact that their teachers, who gate-keep their access to computers to a large extent, view access provision as a significant sacrifice. This perception undermines a major rationale for using such resources, namely as tools which extend learning time and provide feedback, without placing additional responsibilities on already over-worked teachers. The subjective norm provided by the University-led initiative of holding an inter-school competition may have been largely responsible for the teachers being sufficiently motivated in the intervention described here, to be prepared for this sacrifice. However, other solutions, such as use of mobile devices, which learners have greater access to independently of the teacher, may be more appropriate, although other ways to include the teacher in the process then need to be devised since the learners view the teacher's support as a strong subjective norm driving their engagement. This study adds to the existing body of literature showing that the Theory of Planned Behaviour is a useful framework, in a wide range of contexts, for guiding exploration of beliefs affecting ICT usage and formulating suggestions for practise.

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