

Integrating personal mobile devices in teaching: the impact on student learning and institutional support

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Introduction

Anyone walking in the corridors of my educational institution in the United Arab Emirates (UAE) will notice that mobile devices are prevalent. At this particular institution, virtually all Emirati students own either smartphones or mobile phones with advanced features (Santos, 2010; Santos & Ali, 2012). A similar scenario is described elsewhere where students are bringing to schools and universities their personal mobile devices (e.g. Armatas et al., 2005; Burns & Lohenry, 2010). These devices are students' familiar, everyday tools and are becoming their first choice for accessing the Internet and making use of communication services (Lundin et al., 2010; Melton & Kendall, 2012).

Given the high ownership rate, it seems logical to explore opportunities to use students' mobile technology for teaching and learning (Fritschi & Wolf, 2012). Scornavacca et al. (2009) argue that positive learning results can be achieved by encouraging students to bring their personal mobile devices to the classroom and use them to contribute to class activities and to enhance their learning. Some schools and universities are already embracing the 'bring your own device' (BYOD) concept, both inside and outside the classroom, to support teaching activities (Abram, 2012; Cisco, 2012).

Previous research has suggested that mobile devices of various types can effectively support classroom activities (e.g. Bär et al., 2005; Geist, 2011; Milrad & Spikol, 2007; Zurita & Nussbaum, 2004). Most of these studies, however, provided students with mobile devices to carry out learning activities. A loaned device may not be used in the same way as one that is owned, which may impact the evaluation of their use to support learning (Kukulska-Hulme, 2009; Milrad & Spikol, 2007). Studies investigating the use of personal mobile devices to support teaching and learning in the classroom are starting to appear in the literature (e.g. Lundin et al., 2010; Wang et al., 2009). Despite these research efforts, more research is recommended to advance understanding of the role of personal mobile technology both inside and outside the classroom (Mueller et al., 2012; Wang et al., 2009).

Taking into account the need for more research and the evidence of high mobile technology ownership at my institution in the UAE, this paper investigated the implementation of a mobile quiz activity to enhance student learning. As the study adopted students' own devices to support the activity, it also explored the implications of bringing those personal devices to the institution. This study is part of a larger BYOD project implemented within an undergraduate programme during the 2012-2013 academic year, which aimed to investigate the integration of student personal mobile devices in the classroom. This study provides a practical example of student personal devices integration in teaching. As stressed by Wang et al. (2009), these practical examples are much needed to inform instructors on the role of these tools in education. It also informs educational institutions on the implications of bringing personal devices to the classroom. Following a review of relevant literature and an overview of the study, this paper describes the methodology for the case study; the next sections present the results and a discussion around main themes, and the remaining sections address implications for practice and future research.

Mobile devices in the classroom

Within the classroom environment, researchers have investigated how mobile devices can potentially support teaching and learning activities. For example, Geist (2011) and Kinash et al. (2012) examined undergraduate students' perceptions and experiences of using iPads in the classroom. In both cases, students were loaned the devices although Kinash et al. (2012) also encouraged the use of personal mobile devices. Geist found that students considered the iPad a useful tool to access information on the Internet and to read materials during class time; a drawback indicated by students was the inability to complete assignments using the device. Kinash et al. revealed less positive outcomes in which students' use of iPads in the class tended to be more non-educational activities including using the web for pleasure and Facebook reading. Moreover, when asked whether the iPad had improved their learning, more than half of the students remained neutral.

Mueller et al. (2012) surveyed students' use of Blackberries in a first year graduate business programme. Similar to Geist (2011) and Kinash et al. (2012), students were loaned the device with an unlimited data plan. Results indicated that in-class use of the mobile technology reflected more individual and self-directed learning than instructor-led activities; and the overall results showed a modest positive perception of the Blackberry as a learning tool. The authors concluded that instructional pedagogies were needed to support the use of the Blackberry for self-directed learning. This conclusion agrees with Oliver and Gorke (2007) who recommended that instructors create a structure and rationale to effectively integrate mobile devices in classroom activities.

The above studies suggested mixed results regarding uses of mobile devices in the classroom. In contrast, research on classroom response systems using mobile devices has reported more consistent positive outcomes. Early research showed that this technology worked as a catalyst to promote interaction, student motivation and formative assessment (e.g. Dufresne et al., 1996; Jackson et al., 2005; Roschelle, 2003; Menon et al., 2004). Dufresne et al. (1996), for instance, explored the use of a response system in four different undergraduate courses. Questions were presented to small groups and collection of responses was displayed to the whole class through histograms. Results indicated that both small group and whole class discussions helped clarify and improve students' understanding of concepts. In addition, the instructors were able to determine students' level of understanding of course content.

Most of the early studies on response systems relied on personal digital assistants (PDA's) as response units. In this case, PDA's were normally loaned to students or they had to buy them (Bär et al., 2005; Menon et al., 2004). Recently, Internet-enabled mobile devices present an opportunity to develop new classroom response systems (Scornavacca et al., 2009; Markett et al., 2006). Several studies showed that the use of SMS as response medium in the classroom produced positive outcomes (e.g. Cheung, 2008; Lindquist et al. 2007; Markett et al., 2006), similar to the early studies mentioned above. Scornavacca et al. (2009), for example, reported the implementation of interactive quizzes in a large undergraduate class. The instructor presented in-class questions and students sent SMS replies via their mobile phones. Results showed an increase in class interactivity, the classes became more interesting and enjoyable and, to some extent, the quizzes increased students' interest in the subject. A drawback mentioned by the authors was the cost of SMS, which may inhibit its adoption in the classroom. Other researchers reported a similar concern (Lindquist et al. 2007; Markett et al., 2006; Santos, 2010).

In order to avoid incurring costs of text messages on students, Santos (2010), for example, adopted a one-way SMS message communication where students were not required to reply to the quizzes sent by the instructor. The quizzes were sent outside the class and used as a means to promote reflection on course topics and to generate discussion in the next classes. The following is an example of a quiz

question sent to the students: “Which one is correct? Storyboard helps: (1) organize the shots; 2) clarify ideas; 3) both 1 and 2 are correct.” The overall results were encouraging, with most of the students suggesting that the SMS quizzes helped them revise and learn concepts. Cheung (2008), on the other hand, provided students with small payment to offset the cost of text messaging.

Similarly, Wang et al. (2009) reported successful integration of a mobile phone system in a large blended English class. Students used their personal mobile devices to participate in interactive activities including text-messaging questions to the instructor and answering real time polls. These activities provided formative feedback to the instructors on students’ progress with the course, and assisted students to improve their English vocabulary and understanding of sentence structure. The overall experience with mobile learning activities was positive, helping to engage students in the learning process. However, the study indicated some barriers to student participation, such as lack of skills to complete the quiz and slow text typing on the device.

While the above studies used SMS as response medium, Stav et al. (2010) reported the experience of using a web-based response system in a physics course to promote students’ understanding of concepts during class time. The system allowed students to respond to in-class quizzes via multiple mobile devices, and in this study students were loaned iPods before classes. Results from the survey and interviews showed that the quizzes encouraged students to be active in class and helped them learn the course content. The study also indicated some technical problems related to reduced capacity of access to the network, which took a long time to run the quiz sessions. The authors recommended sufficient capacity on the Wi-Fi network and proper location of access pointers.

The studies reviewed above provide valuable information on the use of mobile devices in education. However, some of these studies were projects more interested in testing the technology than studying the teaching and learning process. In addition, many of the studies investigated activities based on borrowed mobile devices. As discussed earlier in this paper, this fact may impact the results. Since the BYOD concept is on the rise (e.g. Norris & Soloway, 2011), this paper focuses on the integration of students’ personal mobile devices in teaching. It has three main objectives:

1. Describe the implementation of a mobile quiz activity supported by student personal mobile devices;
2. Explore students’ perceptions of the mobile quiz to support their learning;
3. Explore the implications of bringing student personal mobile devices into the institution.

Context

The study was conducted in a 15-week face-to-face undergraduate course on educational technology taught at my educational institution in the UAE during semester 1 of the academic year 2012-2013. I taught the course from September 9th, 2012 to January 17th, 2013. Course goals were to prepare students to use a variety of technologies within different teaching scenarios in K-5. Students were required to attend two weekly face-to-face classes consisting of one hour theory followed by a two-hour practice. In-class activities included hands-on practice with technology integration, small group and whole class discussions. The course assessment consisted of a mid-term and an end of semester exam.

The study was approved by the institution’s Ethics Committee. In week 4 of the course, a member of the IT department and the nineteen Emirati female students enrolled in the course were invited to participate in the study; all gave their consent to participate. During this week, students completed a profile questionnaire to indicate the types of mobile devices they owned and the Internet access on

their devices. All students owned mobile phones and two also owned a Netbook and a tablet. Students indicated they carried their mobile phones with them everywhere and all the time. **Table 1** illustrates the types of principal mobile phone owned by sixteen students. Note that three students carried more than one mobile phone; each of these carried a Blackberry as well as one other device: one a Samsung Galaxy and the other two an iPhone.

Table 1: Mobile device ownership

Mobile Phone	Number of students (n=16)
Blackberry	7
iPhone	3
Nokia	1
Samsung Galaxy	5

With regard to Internet access on students' mobile devices, 13 students could access wireless from home. Within this group, a few could also access the wireless using other mobile devices. Among the six students who stated that they had no wireless access from home, one had a data SIM card, two had a subscription to a local Internet service provider (ISP) and two had both a data SIM and a subscription to a local ISP. A single student did not have access to a wireless network from home nor did she have a subscription to a local ISP.

After developing a picture of students' ownership of mobile devices and Internet access, I decided to use students' personal devices to support teaching in the classroom. Similar to other studies (e.g. Stav et al., 2010; Wang et al., 2009), interactive quizzes using a response system were planned. The response medium selected was the commercial, web-based SMART Response™ VE interactive system, which allows students to answer quizzes using Internet-enabled mobile devices both inside and outside the classroom. Responses are automatically collected and represented in graphs or charts on a SMART Notebook page. As with Stav et al.'s (2010) work, the Response VE is compatible with multiple devices. As mentioned above, most of the students relied on a Wi-Fi network, with a few having subscriptions to an ISP, which allows more flexibility in terms of anywhere/anytime access. In this study, the 19 students enrolled in the course were given access to an institutional wireless guest account. All students used the same username and password to access the Internet and were instructed not to share them with other classmates within the institution.

The integration of mobile devices was based on Sharples et al.'s (2009) ideas that the use of mobile technology to support teaching and learning should be driven by specific learning objectives. According to the authors, mobile technology may be suitable for only one part of the learning activity or may not be needed at times. In addition, guided by Gikandi et al.'s (2011) work, the main objective of the quizzes was to establish students' understanding of course content and to promote a discussion around concepts that were not clear.

Methods

This study adopted an exploratory case study design to investigate the quiz implementation via personal mobile devices and its impact on student learning and institutional support. The case study draws on both quantitative and qualitative data as an approach to validate findings through convergence or disconfirmation (Creswell, 2009). Within this approach, data were collected concurrently and occurred

within a single phase. Both methods had the same weight and are collated in the discussion section of this paper. The data gathering tools used in the study are described next.

Questionnaires

I designed two anonymous student questionnaires. A profile questionnaire consisting of checkboxes was administered to students in Week 4 to obtain data on mobile device ownership and types of Internet access. All 19 students completed this questionnaire. An end of semester questionnaire was administered in week 15 to gather information on the students' perceptions regarding key topics: 1) access, 2) use of mobile devices, 3) quiz participation, 4) usefulness of quizzes to learning, and 5) recommendations. The questionnaire had a mixed format including a series of statements with responses on the scale 1 (*strongly agree*) to 5 (*strongly disagree*), with a 'not applicable' response; checkboxes; and open questions. Data were collected at one point in time and 15 students (79%) completed this end of semester questionnaire. The end of semester questionnaire aimed to collect information on participants' perceptions of the quiz implementation using their personal mobile devices to enhance learning. Two colleagues piloted the two student questionnaires by reading the questions and statements and giving their responses; based on their feedback, I clarified words such as 'tablet', simplified some of the statements and improved the overall design of the tools. I also discussed with an educational technology professional the content and coverage of the information needed to address the aims of the study. As a result, a few items were added to the end of semester questionnaire such as reasons for not completing the quiz.

Interviews

Five students were chosen at random (using a SMART board application) to participate in an audio-taped focus group interview in week 15. I adopted a group interview approach (Newby, 2010) in which all students answered each question, although a group discussion was generated around the questions. The main themes covered were 1) access, 2) quiz activities, 3) usefulness of quizzes, and 4) recommendations. In addition, I conducted an audio-taped, face-to-face, semi-structured interview with a member of the Information Technology (IT) department to explore the implications of using students' personal mobile devices in teaching at the institution. The main topics covered in this interview were 1) student access, 2) challenges, 3) support, and 4) evolution of BYOD. I discussed the interview questions with the educational technology professional, who suggested addition of items and simplification of a few questions.

Journal notes and other sources

Between weeks 4 and 15, I kept a journal to record the planning and implementation of the quizzes. The notes focused on the student participation, quiz delivery, potential problems, network issues and the researcher's impressions of the process and procedures. Within the classroom, I became a participant observer (Cohen et al., 2007), delivering the quizzes and participating in the discussions while recording the activities. For the purpose of this paper, the observations were used to write the quiz implementation. In addition, the usage data generated by the SMART Response software were collected, including the number of quiz completions by student, quiz scores by individual question and total scores per quiz. Student responses displayed within the SMART Notebook were also collected (see example in Figure 2). Emails sent to the students and quiz questions were also used as a data source.

Data analysis

As suggested by Cohen et al. (2007), analysis of closed questions from the two questionnaires consisted of assigning a code number to each closed question (e.g. Strongly Agree=1; Not Applicable=6). Next, on a Spreadsheet, I used a column for the respondents' names and a column for each question where the coded information was added. For each column, percentages were then calculated. The percentages for the quiz scores by student and by each question for the weekly scores were automatically calculated by SMART response software which generated a Spreadsheet with the analysis. The average scores per quiz and the number of students who completed the quizzes were calculated manually.

Qualitative analysis of the focus group, the individual interview and open questions from the end of semester questionnaire was based on procedures suggested in Merriam (1998), whereby the researcher codes all the different parts of the data that seem to exemplify similar themes or ideas. Although coding inductively, I kept the research objectives in mind to inform the analysis. I read the documents and made notes in their margins, then grouped these notes to create a preliminary list of codes. The codes went through refinements in which some were refined, linked or deleted. I coded all the documents manually and later assigned data to the categories (e.g. *participation*; *access*) using a word document. Next, I looked at the data within and across categories for themes (e.g. *usefulness of quizzes*). I transcribed the interviews and discussed the list of codes and samples of coding with a colleague. In addition, I shared the interview transcript with the IT staff participant.

Moreover, I typed the observation notes to a word document and analysed these notes following similar procedures described for the interviews and open questions. Examples of the observation codes include *planning*, *access*, and *in-class participation*. Examples of the themes that emerged include *quiz participation* and *quiz organization*. The other sources mentioned above were used as illustrations to support the findings.

The next sections present a description of the mobile quiz implementation inside and outside the class, student quantitative and qualitative data as well as the results from the interview with a member of the IT department.

Quiz implementation

Five quizzes were implemented in the classroom and two outside the class during the mid-term assessment after week 7 (Table 2). In week 5, the quiz was set up in anonymous mode; in the following weeks, students signed in using their ID's. The quizzes were created across the weeks and consisted of a mixture of multiple choice, multiple answer, yes/no and true/false type questions. The questions were designed to test lower cognitive levels in terms of Bloom's taxonomy; see example questions in **Table 3**, each of which consists of a statement or a scenario with a question. The number of questions per quiz ranged from three to five (**Table 2**).

Table 2: Inside and outside class quizzes.

Weekly quiz	Questions per quiz	Quiz completion (n=19)	Average score (%)
Week 5 in-class	3	16	63
Assessment week (out of class)	5	9	71
Assessment week (out of class)	5	12	48
Week 10 in-class	3	14	81

Santos, I.M. (2013). Integrating personal mobile devices in teaching: the impact on student learning and institutional support. *Learning and Teaching in Higher Education: Gulf Perspectives*, 10(2). <http://lthe.zu.ac.ae>

Week 11 in-class	4	14	52.3
Week 14 in-class	4	13	51.9
Week 15 in-class	3	13	92

Table 3: Examples of quiz questions.

Question	Level
<i>When considering using a computer lab, the teacher should do a: ...</i>	Knowledge
<i>The teacher explained to her students how to use a particular technology before they did the activity individually using the computer lab. During the activity, the teacher kept checking each student's work to make sure they knew how to work with that technology. Why did the teacher do the checking?</i>	Comprehension
<i>"Minimize risks when using ICT in the classroom" means: ...</i>	Comprehension

In-class quizzes were completed at the beginning of the lessons. Each student logged on to the SMART Response website, typed the Assessment ID (**Figure 1** (left)) and then her student ID to access and complete the quiz via her mobile device (**Figure 1** (right)).

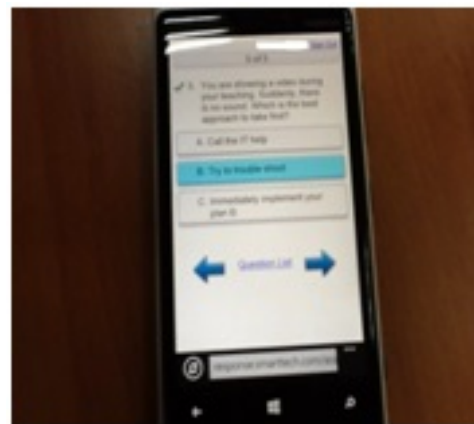
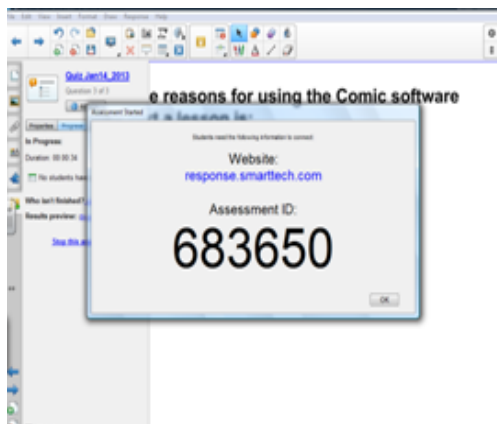


Figure 1: SMART Response quiz: Assessment ID (left) and example of quiz on student mobile device (right).

The in-class quizzes were set up not to give students the answers to the questions. After submitting the quiz, the response for each question appeared on the SmartBoard (Figure 2) and a whole class discussion was promoted before the correct answer for each question was given to the students. The two outside class quizzes, on the other hand, were set up to give students the answers after submission.

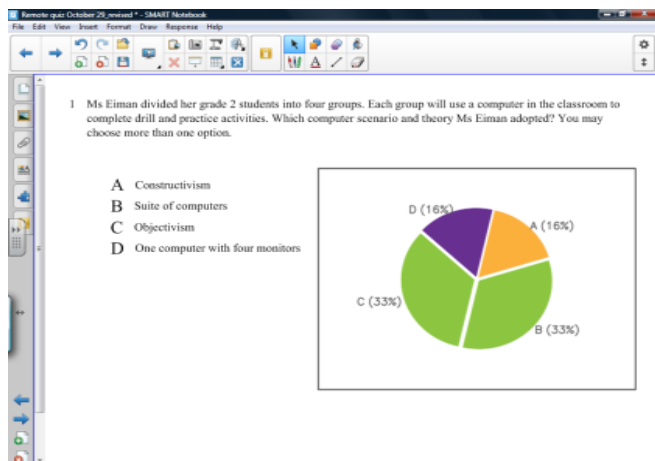


Figure 2: Summary of quiz responses on SmartBoard.

Students and the instructor agreed on a schedule to deliver the outside class quizzes. Students were to receive an SMS from the instructor to inform them about the SMART Response Assessment ID. Since one student did not have Internet-enabled mobile devices at home and some did not participate in the quizzes (**Table 2**), the instructor sent an email to the class with the quiz questions. The answers were sent to students by email on the next day.

Overall, **Table 2** suggests more student participation in quizzes in-class than outside the class. Further analysis revealed that ten students participated in more than two in-class quizzes, six completed two and three completed one. Seven students did not complete the outside class quizzes. **Table 2** also shows the average quiz scores per week. Generally speaking, students performed better in week 15 (mean: 92%) followed by week 10 (mean: 81%). In contrast, week 11 recorded the weakest in-class average scores. With regard to the outside class quiz scores, results clearly indicated better scores in quiz 1 (mean: 71%) compared to quiz 2 (mean: 48%). The weakest overall average scores were obtained in quiz 2 (mean: 48%).

Results from student data

End of semester questionnaire

The majority (93%) of the students used smartphones to complete the in-class quizzes and one used an iPad. 67% of the students were connected to the institutional guest account to complete the quizzes while 33% used their own Internet subscriptions. All students who completed the outside quizzes (N=12) said they used smartphones. Two, who did not complete the outside quizzes, said they were busy, while another mentioned other reasons. When the instructor sent the SMS to the students, 86% stated they were at home. One (7%) was at the shopping centre and another was out in the street. Results showed that 93% felt it was easy to complete the quizzes via their mobile devices, with 60% strongly agreeing. Many (74%) agreed that they had no problems using their mobile devices to complete the quizzes. Two students (13%) had problems and two others were neutral.

Table 4 illustrates the perceived usefulness of the quizzes for students' learning of content. Overall, it suggests positive results: the majority of the students agreed that the quizzes promoted class discussion and that through the discussions they learned the concepts.

Table 4: Perceived usefulness of the quizzes.

Statement	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)	N/A (%)
After completing the quizzes, I realized I knew the content less than I thought.	20	33	27	13	7	
The quizzes confirmed my understanding of the content.	20	33	47			
The quizzes helped me revise concepts.	33	53	13			
The quizzes encouraged me to study the content more.	33	53	13			
The classroom quizzes were useful to generate a discussion.	40	53	7			
The discussions based on the quizzes helped me learn the concepts.	33	60	7			
The outside class quizzes were useful to review concepts before the exam.	33	33	13			20

As seen in Table 4, the majority felt encouraged to study more after the quizzes. Results indicate agreement among most of the students that the quizzes were useful to revise concepts. The quizzes helped 53% realize they knew the content less, while 27% were neutral and 20% disagreed.

Qualitative results

In the focus group interview all five students indicated completing the in-class and outside quizzes using their phones. Four students said they had not had Internet access on their phones before this study and one had had a subscription to an ISP. The latter mentioned she could not use the institutional guest account. She explained: "It does not work. I was never able to connect to the guest account." Two students had problems with the password and ID but managed to connect to the guest account. When outside the class and within the institution, three students lost connection to the guest account. A further student said that although the connection worked outside the class, the signal was very poor.

The five students said the quizzes enabled them to check their understanding as well as what they did not know about the content. One student stated: "... When you do the quiz, you think - oh I don't know; this is new information to me." A student who got the answers correct felt that "Maybe it was correct by luck... I was confused, for example, if it [the answer] was troubleshooting [sic] or something else." Two students considered the quizzes to be good practice for the exam. In the open ended questions from the end of semester questionnaire, three said that the quizzes enabled them to check their understanding of concepts. Two others found the quizzes useful as a means of review for the exam and another felt the quizzes "improved our learning." All students in the focus group agreed that the number of questions was appropriate. One said: "...if it is more, I think it will take more time."

After completing the quizzes, the five students felt the need to study more. One student said: "You need to go back and study... [the quizzes] make us think about the things we need to study more." In addition, students indicated they called each other to check the answers. One explained: "...you have the

answers after finishing the quiz... It was only correct or wrong.” Another added that “...sometimes we got confused why your [instructor’s] answer is correct and why my answer is wrong.” The same student mentioned they used Blackberry Messenger and WhatsApp to contact each other.

The five students felt the mobile phone device offered them flexibility to complete the quizzes; for example: “You have your phone in your hands; no need to go somewhere to do it.” Two students said it was easy to complete the quiz using their phones. Six students expressed a similar opinion in the open ended questions from the questionnaire. However, results indicated that there was agreement among the five students that accessing the guest account was what they liked least in the study. Two indicated a similar opinion in the questionnaire. A student wrote: “We keep losing Internet connection several times so we need to log in again [and] again.” Two students in the focus group recommended that the institution provide stronger Internet connection on “our mobile phones.” Four students in the questionnaire made a similar recommendation.

Institutional support

An interview was conducted with an IT staff member to explore the implications of bringing students’ mobile devices to support the mobile quiz activity. Four key themes emerged from the qualitative analysis and are discussed next.

Students’ current access: the interviewee explained that students were provided with a guest account because it allowed change of the password in case there was a problem. The access resembled a “hotel type experience” where students had to type the ID and password to access the Internet. Although there was no increase in bandwidth usage, the interviewee stressed that students could have potentially shared the password with other students. Suddenly, more students would be bringing in their mobile devices and having Internet connectivity. According to the interviewee, this did not happen. A possible reason for students not sharing the password could be that either they “found the process too restrictive” or “felt part of something special and they did not want to abuse [it].” The interviewee added that “if they had the access all the time [to the guest account] maybe we would have had bandwidth issues.”

Improving student access: to enable more students to access the Internet on their mobile devices, a personal network needs to be set up. The interviewee explained that students’ devices could be registered on a segregated network from the corporate network. This solves the security issues of having mobile devices on the institutional network; however, it creates a capacity issue. He said:

In the current situation, we’d have probably to increase the bandwidth...Those devices consume bandwidth ... To increase the bandwidth... we have to spend money on our network to bring up to a point that we can support a high number of devices...we have to prove this is something that is so worthwhile that we have to put in more wireless access points... I would hope the reason would be that you prove there will be learning and teaching outcomes... to justify the cost.

The interviewee indicated that with the current infrastructure, the level of access that IT supported in the current study was the maximum number they could support in the future. However, he warned that this would create an equity issue among students: “...if you can’t do it for all, then how can you justify doing it with a selective [group]?”

Student support: with regard to support of students’ mobile devices, the interviewee felt that “... we are a long way... from seeing the actual devices being supported.” At the institution, the IT personnel support a range of devices that they are familiar with. Students might start bringing in different types of mobile devices with different applications and technologies which make it difficult to know what is

available on it. According to the interviewee, IT support for mobile devices will be more about bandwidth and distribution of applications to a

device which has very little support requirement compared to... a laptop, which can have a number of things that can go wrong... sometimes we are possibly worrying about this whole support to [mobile] devices when it is really a non-issue.

The way forward: the interviewee was aware that mobile devices are part of our lives and it is inevitable that both faculty and students will bring their own devices to the institution. He said:

I would say within 18 months here we would have to be providing access to the students somehow... When I say access, I mean connectivity. So at a basic level, you are going to have to provide connectivity... Otherwise you would become irrelevant... We would also have to have a budget... we are talking about half million more... We have a 40mg connection... In terms of bring your own device [you] have to double that.

According to the interviewee, "...most of the students on a personal device... want connectivity."

Discussion

This study explored the integration of a quiz activity supported by students' everyday tools and its impact on student learning. These devices were used as a means to promote formative assessment and class discussion through quizzes. Agreeing with previous studies (e.g. Scornavacca et al., 2009; Stav et al., 2010; Wang et al., 2009), the quizzes helped promote in-class discussions in which the majority of students benefited from learning course content. Based on students' qualitative data, the outside quizzes also facilitated to some extent a discussion among students (and internal reflection) in which they tried to understand the answers given by the SMART Response software. In the in-class quizzes, the instructor encouraged a discussion around each question before revealing the answers: the 'why your answer is correct and why my answer is wrong' was discussed in class led by the instructor. Outside class, results suggested that this could become a student-initiated activity. In addition, the quizzes supported revisions of concepts and many students considered them useful to revise concepts before the exam. Similar findings were reported by others (Jackson et al., 2005; Santos, 2010).

The quizzes also encouraged most of the students to study more. Students' qualitative comments corroborate students' perceptions of the need to study more. This perception might have been influenced by the average scores shown in **Table 2**, which does not show consistent positive results across the weeks. Dufresne et al. (1996) also found that the class response system helped students check their learning progress in class; however, in Dufresne et al.'s study students felt confident about their understanding of course content. The positive average scores shown in **Table 2**, on the other hand, might have worked as confirmation of understanding to more than half of the Emirati students.

Similar to Wang et al. (2009), findings indicated an overall positive experience with clear learning outcomes. However, this study revealed a few challenges related to the quiz implementation. While all students owned sophisticated mobile devices (**Table 1**), many did not have constant Internet access. The in-class quizzes could be implemented only with institutional support that enabled wireless access on students' devices. In addition, the outside quizzes were not completed by all students enrolled in the course. As discussed earlier, only students participating in the study were given Internet access on mobile devices at the institution. All these situations created an equity issue of the kind discussed by Norris and Soloway (2011) in relation to BYOD. One may argue that not all the students completed the five in-class quizzes and this may create an equity issue. The number of in-class quizzes completed by students ranged from one to five quizzes. In this case, students were supposed to be attending classes.

They missed the quiz activities as they would miss any other activities happening in class time. Perhaps participation would have been higher if in-class quizzes were delivered at the end of lessons.

Evidence suggested higher participation in in-class quizzes. The outside class quizzes were sent before the mid-term exam, which could have worked as an incentive for participation. Results showed that 86% of the students were at home when the instructor sent the SMS for them access the quizzes. It could be that they were busy at that particular time, as suggested by a few. However, more research is needed to ascertain reasons for students not completing the outside quizzes.

This study started by providing evidence to justify the costs for improving the institution bandwidth to enable Internet access on students' personal mobile devices. There were clear learning outcomes, the majority of students liked the idea of using their mobile devices in class and many recommended other instructors to use students' personal mobile devices. There were only minor technical problems and the majority of the students found the process of accessing the quizzes easy. This may indicate that students may not need IT support, which contrasts with Jackson et al.'s (2005) study that reported students requiring IT assistance with their devices. Perhaps all that students needed was connectivity on their devices. It seems they wanted Internet access on their mobile devices beyond class time. However, the purpose of accessing the guest account was for in-class activity and it worked well. This finding contrasts with Stav et al.'s (2010) study that found problems with network connectivity. Nevertheless, had access to the guest account been more stable, perhaps there would have been problems with bandwidth usage, which was noted in the interview.

Implications for practice

Key factors might have contributed to the positive outcomes. The integration of mobile devices in the classroom was not driven by technology. Rather, and based on others' work (Gikandi et al., 2011; Oliver & Gorke, 2007; Sharples et al., 2009), the quizzes were planned with a pedagogic purpose in mind. This finding corroborates Mueller et al.'s (2012) conclusion for the need of pedagogical strategies to effectively use a mobile device as a learning tool. In addition, making sure that all students had access to a mobile device and Internet access, as well as finding strategies to solve equity issues, made the implementation process more transparent. Moreover, agreeing with Dufresne et al.'s (1996) findings, creating quiz questions can be time consuming, although the questions can be re-used in future classes. Alternatively, instructors could plan activities in which students create their own questions. Finally, setting up the quizzes using students' ID proved to be more effective as it enabled the instructor to identify students' learning progress both at individual and whole class level.

Future research

Despite the positive outcomes, this study was, of course, based on a single case and a small sample size. It also focused on one type of mobile based activity, which required Internet access. As instructor of the course, I took an active role in the study, which might have influenced students' responses to the questionnaires and focus group interview; thus, care must be taken when interpreting the findings. To validate and expand the findings, other studies could include larger samples, different groups of students and implementation of other types of activities using multiple mobile devices or single devices. Further research is recommended to investigate reasons for the lack of full student participation in the outside class quizzes. Researchers could also investigate whether the design of quiz questions impacted students' performance, as well as experimenting with higher order thinking questions.

In addition to the ideas discussed above for further research, this paper and the other presentations delivered by colleagues during the research symposium *Mobile Learning: Gulf Perspectives* on April 25,

2013, worked as an incentive to inspire participants to develop their own research agenda on mobile learning within the Gulf region. During the workshop led by Professor Mohamed Ally from Athabasca University and myself, we brainstormed ideas on possible topics that participants might be interested in researching. We held fruitful small group discussions on how to narrow down a research idea and procedures for conducting research, including encouragement for publications in conferences and peer reviewed journals. The symposium on mobile learning in the Gulf region was not only an event for us, plenary presenters, to share our research studies and experiences on mobile learning with an audience; it also enabled the audience to get involved in developing ideas for future research which they can implement and share their findings through publications and workshops. For example, a few will focus on the use of iPads to promote collaborative learning; others will experiment with mobile devices to support English language learning or implement strategies to improve a particular learning skill. Such studies are much needed in the Gulf region to inform us how mobile devices can support teaching and learning inside and outside the classroom.

Conclusion

This paper provided a practical example of how to integrate students' personal mobile devices in and outside the classroom to enhance learning. The interactive quizzes delivered via students' personal mobile devices worked as a catalyst to promote inside and outside class discussion and to support students' learning of course content. A few challenges and key factors contributing to positive outcomes were discussed. A major implication of bringing your own device to the institution relates to the capacity of the wireless infrastructure to enable a more stable and equal Internet access on students' personal mobile devices. Without such support, the BYOD model cannot be fully implemented at the institution, which creates an equity issue among students.

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