Students’ use of Asynchronous Voice Discussion in a Blended-Learning Environment: A study of two undergraduate classes

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Abstract: Contemporary discussions of education in blended-learning environments increasingly emphasize the social nature of learning which emphasizes interactions among students, or among students and instructors. These interactions can occur asynchronously using a text based discussion forum. A text-based discussion forum, however, may not work well for all participants as some find it difficult to explain complex concepts in words, while others complain of being misunderstood due to the absence of verbal cues. In this study, we investigated the use of a Wimba Voice Board to support asynchronous voice discussion. A quasi-experiment research design involving two classes of undergraduate students was conducted. One of the classes (n = 24 students) used the Wimba Voice Board while the other (n = 18 students) used a text discussion forum in BlackBoard. The results of an independent t-test analysis suggested that there was no significant difference in the students' degree of participation in the two classes, asynchronous voice discussion class (M = 2.92, SD = 1.586) and text discussion class (M = 2.78, SD = 1.353), (t = 0.299, df = 40, p = 0.767) at the 0.05 level of significance. However, the online discussion appeared to be more sustained in the asynchronous voice discussion group. Analyses of the students’ reflection data suggested that asynchronous voice discussion have several advantages over text forums. Specifically, an asynchronous voice discussion: enables students to understand one another’s messages better, allows students, who prefer speaking to writing, or students who are not proficient in written English, to participate in the discussion, promotes originality of students’ ideas, and helps to foster a sense of online community.

Keywords: blended-learning, asynchronous online discussion, voice board, discussion forum, participation, Wimba Voice Board

1. Introduction

The use of the blended learning approach is increasingly being adopted in many colleges and universities around the world (Cheung and Hew 2011). However, many scholars and educators realize that it is not sufficient to merely place content on a web site for students to read or download materials for a blended learning course to be successful. Maximizing success in a blended-learning environment requires a well-supported approach (Dzuiban et al., 2004) that includes on-going technical support for both faculty and students, as well as opportunities for students to interact with one another, among others. In fact, contemporary discussions of education increasingly emphasize the social nature of learning (Palincsar and Herrenkohl 2002) which emphasizes interactions or discussions among students, or among students and instructors. A discussion provides a means for students to exchange opinions, share multiple perspectives, and clarify various thoughts (Dunlap 2005). Some scholars have identified student discussion as being one of the activities that students found most beneficial to their learning (Ertmer et al 2007; Richardson and Swan 2003).

In a blended-learning environment, discussions among students and instructors may occur synchronously or asynchronously over the Internet. The former such as chat room requires students to simultaneously log on to the software or platform in order to interact with one another, while the latter such as Google Group does not. Of the two modes of communication, the time-independent nature of asynchronous discussion makes it particularly well received by many educators (Hew, Cheung and Ng 2010; Romiszowski and Mason 2004) because participants can choose to post their comments or questions at their own convenience. In addition students have time to respond to other students’ comments (Murphy and Coleman 2004), which could help students develop critical thinking skills, and solve ill-structured problems (Hew and Knapczyk 2007).
In this paper, we report a study of two undergraduate classes situated within the context of teacher education. Students in these two classes attended face-to-face tutorials, in addition, to working independently in their own time during the online component. One of the classes used the Wimba Voice Board, while the other employed a threaded text based discussions forum. The Wimba Voice Board allows users to record and post audio messages. The audio messages are arranged in threads, similar to threaded text discussion forums. Students also have the option of typing a text description to be appended to the audio clip. The text description can be entered in a small text box located at the bottom of the Wimba Voice Board screen. At the end of the two classes, students' online posts were tabulated. In addition, students' reflection about the advantages of voice-discussion were coded and counted. An independent t-test analysis suggested no significant difference in terms of number of message posted between students who used the Voice Board and their text-based counterparts. However, the online discussion appeared to be more sustained in the asynchronous voice discussion group. Analysis of the reflection data indicated that voice discussion has several advantages over text based discussion.

2. Literature review

In this section, we discussed the importance of student participation in asynchronous online discussion, followed by a summary of some past available research on asynchronous voice discussion. First it is important to note that the benefits of asynchronous online discussion can only be enjoyed if students choose to participate in the discussions in the first place (Hew & Cheung, 2008). If no postings of messages are made, there will be no messages for students to read in the first place, let alone discuss. Indeed, the findings of several previous studies have suggested that a necessary, if not sufficient, condition for a discussion to aid learning is for students to participate by posting a sizeable number of messages such as comments or questions (Davies & Graff, 2005; Gaspar, Langevin, Boyer, & Armitage, 2010; Nagel, Blignaut & Cronje, 2009; Palmer, Holt, & Bray, 2008; Yukselturk, 2010). Nagel et al. (2009), for example, reported that high performing students on average were active in the discussions. They posted their viewpoints and responded to other students' comments. Students who failed or abandoned a course, on the other hand, posted on average significantly fewer messages in the online discussions than their successful counterparts.

Unfortunately, more often than not, student participation in online discussions is limited (Hew & Cheung, 2012). Previous studies have found that students tend to post very few messages in the discussions. Wan and Johnson (1994), for example reported that students posted less than one message per week, while Kucuk et al. (2010) lamented that close to 95% of students did not contribute a single note in the online discussion. One possible reason for this lack of student participation could be the medium by which the online discussion is conducted.

Many of the current asynchronous online discussion environments are text-based and require typing skills and a keyboard (Girasoli and Hannafin 2008). This, however, may not successfully meet the needs of all students; therefore their participation in the online discussion tends to be minimal. Some participants, for example, find it difficult to explain complex concepts using the text-based discussion, while others find that they run the risk of being misunderstood due to the lack of verbal cues (Hew and Hara 2007). Still others find it very burdensome to read and respond because they have weak reading or writing abilities (Bowe, 2002). In order to overcome this obstacle, we have begun to examine the use of asynchronous voice discussion. Some of the available technological tools that support asynchronous voice discussion include the Wimba Voice Board, and Voice Thread.

The use of audio or voice in blended-learning is, of course, not new. According to Yaneske and Oates (2010), audio has been employed for many years through radio, audiocassettes, compact discs, and recently podcasts, which refer to audio files that can be automatically downloaded to a learner's computing device. However, such voice technologies suffer from a lack of interactivity (Junor 1992). Many instructors tend to use these technologies to transmit information one-way to the students. In an extensive review of podcast, Hew (2009) found that the most common use of podcasting is limited to either the instructor distributing voice recordings of lectures or supplementary materials (e.g., assignment tips) for students to listen and review the subject matter at their own time and pace.

The use of asynchronous voice discussion, however, provides a means for multiple-way interaction such as students interacting with other students, or with the instructor. Similar to text-based discussion tool, asynchronous voice discussion technologies such as Wimba Voice Board and Voice
Thread are independent of time and geographical location; hence allowing students time to think and respond.

Overall, our analysis of the literature suggested that asynchronous voice discussion has the following advantages: it helps participants, particularly students who are learning English as a second language, to practise speaking, listening, and do self-diagnosis of pronunciation errors (Gleason and Suvorov 2011; Yaneske and Oates 2010), it can help increase social presence because the ability to hear other people’s voices helps foster a more personal connection to them (Yaneske and Oates 2010), it is relatively easy to use (Gleason and Suvorov 2011; McCormack 2010), it provides a more natural and hence easier way to present ideas and respond to others (Marriott and Hiscock 2002), and it provides participants with a richer means of communication such as verbal cues and emotional context which helps enhance the meaning of a message posted (Marriott and Hiscock 2002; Yaneske and Oates 2010). This last advantage could potentially help the receiver understand a sender’s message better and therefore reduce the risk of misunderstanding. Consequently, this may promote more student participation in the online discussion.

On the other hand, some of the challenges of using asynchronous voice discussion include the following: it is difficult to correct errors because participants were unable to edit the recordings once they were posted (Gleason and Suvorov 2011; Marriott and Hiscock 2002), some participants were embarrassed to record their voices and let others hear how they sounded (Marriott and Hiscock 2002; McIntosh et al 2003; Yaneske and Oates 2010), the absence of an ability to sort and search messages (Yaneske and Oates, 2010), and an inability to skim audio quickly forces participants to replay the message repeatedly should they want to hear something again or could not hear it properly (Yaneske and Oates 2010).

We found several limitations concerning the existing research on asynchronous voice discussion. The studies were limited to an examination of students’ affective outcome such as their satisfaction of using asynchronous voice discussion. This highlights the need to investigate whether the use of asynchronous voice discussion could affect other outcomes such as students’ degree of participation. The majority of studies focus on disciplines such as communications studies or second language learning, and involved students from North America. Therefore, there is a need to examine other contexts such as students from the Asia Pacific region to better understand the use of asynchronous voice discussion.

3. Research questions
The study addresses the following research questions:

- Is there a significant difference in the degree of students’ participation in asynchronous voice based compared to text based discussion?
- How do thread depths differ between the asynchronous voice and text based discussion groups?
- What advantages do asynchronous voice discussions have over text based discussions?

4. Methodology

4.1 Participants
This study is situated in an Asian-Pacific, teacher education context. A total of 42 undergraduate students from a teacher education institute participated in the current study. The 42 students came from two classes of 24 and 18 each. The ages of the students were between 19 and 24 years old. All 42 students were studying for a bachelor’s degree in education at the time of the study. The same instructor taught the two classes for a semester (12 weeks) on the same topic entitled Use of Technology in Teaching and Learning. In both classes, students used the same course materials, did the same assignments, attended face-to-face tutorials, as well as worked on their own time and at their own pace during the asynchronous discussion component.

4.2 Procedure and data analysis
A mixed-method research design approach that involved the collection and analysis of both quantitative and qualitative data was carried out in this study. One of the two classes (n = 24 students) used the Wimba Voice Board while the other (n = 18 students) used a text discussion forum. It is to be noted that the Voice Board class had used a text discussion forum before in their
previous classes but this was the first time they employed an asynchronous voice discussion forum. Therefore, students in the Voice Board class were given an introduction to the tool, along with some hands-on-experience before the actual class online discussion commenced. Both the Voice Board and the text discussion forum were available in BlackBoard. The two classes used the same topic for their discussions – *How can teachers engage students during an online discussion?* In addition, both classes were given the same time duration of two weeks to complete the discussions.

To answer question (1) “Is there any significant difference in the degree of students’ participation in asynchronous voice versus text discussions?”, online messages posted by the students in the asynchronous voice and text discussion platforms were analyzed. The number of postings was tabulated and the difference between the classes was examined using an independent sample t-test.

To answer question (2) “How do thread depths differ between the asynchronous voice and text based discussion groups?”, we also examined the students’ online messages. Specifically, we refer thread depth to the number of messages that are linked together consecutively in a particular thread. For example, a thread that has only a starter message has a thread depth of one, while a thread that has a starter message and one reply has a thread depth of two, and a thread that has three consecutive messages has a thread depth of three (see Figure 1). According to Hew and Cheung (2008), a greater thread depth not only suggests that an online discussion is taking place but also the possibility that the discussion is sustained. A sustained discussion should ideally be the norm because it usually takes more than a few message exchanges for students to share opinions, negotiate issues, and create mutual understandings (Guzdial & Turns, 2000). Essentially, a thread that has only a thread depth count of one is an orphaned thread; it is basically a dead thread that does not generate any responses at all. A thread that has a depth of two is also very limited because there is no further response beyond the second message.

Figure 1: Thread depth

<table>
<thead>
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<tbody>
<tr>
<td>Thread depth = 1</td>
<td>Thread depth = 2</td>
<td>Thread depth = 3</td>
</tr>
</tbody>
</table>

To answer question (3) “What advantages do audio discussions have over text based discussions?”, students who used the Wimba Voice Board were asked to comment on two open-ended questions at the end of the course: “What do you think are the benefits of using asynchronous voice discussions?”, “What do you think are the challenges of using asynchronous voice discussions?” The students’ open-ended responses were examined by a qualitative coding approach that followed the methods of Neuman (2006).Basically, the students’ responses were initially examined to group similar comments into themes. The relationship between the themes and the fit between each statement and the theme were then evaluated. Finally, each theme was given a label and a representative statement for each was selected.

5. Results and discussion

*Is there any significant difference in the degree of students’ participation in asynchronous voice versus text discussions?*

The results of the independent t-test analysis suggested that there was no significant difference in the students’ degree of participation in the two classes, asynchronous voice discuss class (M = 2.92, SD = 1.586) and text discussion class (M = 2.78, SD = 1.353), (t = 0.299, df = 40, p = 0.767) at the 0.05 level of significance, although the mean number of posts in the former was higher than that in the latter.

From this result, we may conclude that students tended to participate more or less equally in either asynchronous voice or text discussion forum, despite the findings of some previous research studies suggesting that voice discussion provides a more natural and hence easier way to present ideas and
respond to others, as well as its ability to increase social presence due to the ability to hear other people’s voices (Marriott and Hiscock 2002; Yaneske and Oates 2010).

Why is this so? Analyses of the students’ reflection open-ended responses suggested that not all students find the Wimba Voice Board a convenient tool. Some students complained that they could not edit their voice postings if they said something wrong. Instead they had to delete their entire voice postings and record their voices again. This whole procedure of delete-and-record-again makes it very bothersome for some students to participate in the voice discussion.

We also found some participants being very self-conscious about how they sounded in the asynchronous voice discussion environment. Several students reported that they were afraid of appearing foolish should they speak too fast or that their voices sounded too high pitched, while others felt awkward speaking into a microphone.

How do thread depths differ between the asynchronous voice and text based discussion groups?

Although there was no significant difference in the number of messages posted by the two groups, we found that the asynchronous voice discussion group had an overall greater thread depth (see Table 1).

Table 1: Comparison of thread depth between the asynchronous voice and text based discussion groups

<table>
<thead>
<tr>
<th>Type of discussion</th>
<th>Thread depth</th>
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<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Voice</td>
<td>4</td>
</tr>
<tr>
<td>Text</td>
<td>6</td>
</tr>
</tbody>
</table>

On the whole, the asynchronous voice discussion group had five 3-level deep threads and three 4-level deep threads, while the text discussion group had only three 3-level deep threads, and zero 4-level deep threads. This suggests the possibility that the online discussion is more sustained in the voice discussion group. We also found the text based discussion group had twice as many threads that were only two-level deep as compared to the asynchronous voice group. This indicates that a sustained discussion is not really taking place in the text group because such threads contained only two posts – the starter message and a reply to the starter.

One possible reason for finding more sustained discussions in the asynchronous voice group is the ability of the spoken word to project a sense of actually dealing with real people as compared to text discussions. According to Durbridge (1984), this sense of realism could motivate an individual to continue conversing with other people. This is highlighted by the following representative students’ statements:

“A voice-based discussion, clearly gives the sense of dealing with real people because we get to hear their voices, making us feel as if we are in a real discussion rather than within the boundaries of technology [sic].”

“A voice forum appears more personal [as we can hear people’s voices], hence creating a closer sense of realism for communicating with real people in real-life [sic].”

“The voice-based discussion instills a sense of actually dealing with real people as it is more realistic with real voice, intonation and emotions, compared to the mere reading of printed texts off the computer screen [sic].”

What advantages do asynchronous voice discussions have over text discussions?

Analyses of the students’ open-ended responses revealed several advantages of using voice discussions. We discuss four main ones in this paper. First, students were able to understand one another’s messages better because they could hear the tone and emotion expressed by the voice participants. This finding is consistent with that reported in some of the previous studies (Marriott &
Hiscock, 2002; Yaneske & Oates, 2010). The following representative statements from some of the students’ data help to illustrate this point:

“We are able to interpret not only the ideas presented but how it is presented such as the intonations that may give us a clearer picture of the message posted [sic].”

“In my opinion, through voice-based discussions, participants will be able to portray their feelings through the tones of their voice. This will enable those who listen to them to better understand what they are trying to say about a certain issue [sic].”

Second, the use of asynchronous voice discussion is particularly useful for learners who prefer talking to writing, or who may not be proficient in the use of grammar as highlighted by the following comments:

“It [asynchronous voice discussion] comes in handy for those who are better in speaking than in writing. This will ensure that he/she is able to raise his/her views clearly and avoid confusion [sic].”

“Voice-based discussions have several advantages such as enabling a participant to voice out his/her views as much as possible without having to worry about grammar or vocabulary as compared to writing, hence making the person actually enjoys what he or she is doing [sic].”

Third, we found that the use of asynchronous voice discussion could help promote originality of ideas. Results of our analysis suggested that this was mainly due to the spontaneity nature of voice discussion. The following representative statements from some of the students’ data help to illustrate this point:

“It is more in promptu. People tend not need to over think before they say, and hence their spoken comments provide a more realistic picture of what they actually feel [sic].”

“It enables us to speak our minds without the need for any type and delete, type and delete going on. It will be like truly speaking our mind without any hesitation [sic].”

Fourth, the use of asynchronous voice discussion could help foster a sense of online community:

“I think that a voice-based discussion puts forth the notion of the strong sense of online community because we (virtually) let our voice and opinions be heard and when all of these ‘voices’ come together, a sense of unity is felt, together with shared emotions that we hear from the voices [sic].”

“It creates a stronger sense of online community within a group because we could actually listen to each other. This would help to bond us together [sic].”

6. Conclusion

In this study, we investigated the impact of using asynchronous voice discussion on the degree of student participation. We also explored the students’ perceptions of the advantages of asynchronous voice discussion. Overall, the results of the current study showed no significant difference in terms of the number of message posted between students who participated in the asynchronous voice discussion environment and their text-discussion counterparts. However, the online discussion appeared to be more sustained in the asynchronous voice discussion group. In addition, students who took part in the asynchronous voice discussions reported four main advantages of using audio. These include: the ability to understand someone better due to the presence of emotions and tonal cues, greater convenience and ease for students who prefer speaking to writing or who are weak in grammar to participate in the online discussion, the ability to foster a sense of online community, and the ability to help promote originality of ideas due to the spontaneity or impromptu nature of oral communication.

Due to the relatively small number of participants (n=42), the results of this study should be interpreted with caution. A larger sample would be needed to further test and confirm the veracity of the findings. Whether the findings would hold true with students from other courses, disciplines and academic abilities is unclear.

The actual online discussion in the current study took place over a relatively short period of two weeks. For many students, this was the first time they recorded their voices using microphones.
Therefore, it is not very surprising that some students felt a sense of awkwardness using the asynchronous voice discussion tool. Whether the students would participate more often on the Voice Board platform when this sense of awkwardness fades is still uncertain.

Despite these limitations, we believe that the findings are useful to other researchers and educators who are similarly interested in examining the use of asynchronous voice discussion in e-learning or blended-learning environments. For future research, we suggest that a longer duration of study be conducted. Perhaps, students could be given the opportunity to participate in asynchronous voice discussion for an entire semester. Further research about the use of asynchronous voice discussion should also be conducted using a larger cohort of students from various disciplines.

We also urge future research to examine aspects of students’ performance outcome such as their level of critical thinking in asynchronous voice discussion environments, and how these may differ from text-input forums. Students’ level of critical thinking may be assessed in terms of their level of information processing – surface or in-depth. Surface level of information processing includes: making prediction, generalizations, conclusions or judgements without offering justification or suggesting which is most appropriate, sticking to prejudices or assumptions, and off-topic/faulty reasoning (Cheung & Hew, 2006). On the other hand, in-depth level of information processing may involve setting out the advantages and disadvantages of an idea or solution, making prediction, generalizations, conclusions or judgements supported by justification, providing proof or examples, and bringing outside knowledge or experience to bear on problem (Cheung & Hew, 2006). Other students’ performance outcomes that could be investigated include the levels of student social construction of knowledge, and student problem solving skill (Hew, Liu, Martinez, Bonk, & Lee, 2004).

Finally, future research should also examine the use of asynchronous voice discussion on small screen wireless mobile devices. Examples of such devices include PDAs with wireless access and smart phones (e.g., iPhones) (Cheung & Hew, 2009). Since it is not easy for students to post messages using a text-based input on small screen mobile devices, asynchronous voice discussion input via built-in microphones may be a viable alternative. Furthermore, the cost of text entry may be too high to scale towards multiple communication sessions using mobile devices (Zinman, 2006), hence asynchronous voice could be a superior medium to support scalable group communication.

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Review of Use of Animation as a Supplementary Learning Material of Physiology Content in Four Academic Years

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Abstract: Dynamic concepts are difficult to explain in traditional media such as still slides. Animations seem to offer the advantage of delivering better representations of these concepts. Compared with static images and text, animations can present procedural information (e.g. biochemical reaction steps, physiological activities) more explicitly as they show the steps in an orderly manner. Quite a few empirical studies showed promising results animations have on learning (e.g. Trevisan, Oki and Senger, 2009; Hays, 1996). There are, however, also limitations. Designing and developing quality animations for teaching and learning can be challenging sometimes (Morrison, Tversky and Betrancourt, 2000). Kesner and Linzey (2005) even found no improvement on students' learning in using animations in their study. It thus occurs to the researchers that there are factors that govern successful use of animation in teaching and learning. Our study explored such factors in the context of physiology teaching. 913 students in twelve different classes (collected in two stages, four years in total) in the same physiology course learned complicated microscopic mechanisms with assistance from animations provided as supplementary materials primarily for self-study. Surveys and group interviews were conducted that provided both qualitative and quantitative feedback. Results were mostly positive - animations surely explain contents more explicitly to students (especially for the explanation of dynamic and complicated biological processes), make students more interested in the subjects taught; and there is a greater demand for similar learning tools from the students. It is strongly believed that animations are good supplementary learning materials for students particularly for learning complicated concepts. Important success factors we found included the detailed explanation of content, a good balance between clear presentation and beautiful interface, the speed of running/loading of the animations, and the provision of more references, etc.

Keywords: teaching dynamic physiology process, supplementary use of animation, advantage of animation in teaching, successful factors of using animation, animation for student revision, learning with animation

1. Animation in teaching and learning

Dynamic concepts are difficult to explain in traditional media such as still slides. Animations seem to have the advantage of delivering better representations of these concepts. A wide range of subject areas such as chemistry and computer sciences are currently using animation to demonstrate their course contents (e.g. Kehoe, Stasko and Taylor, 2001; Payne, Chesworth and Hill, 1992; Dyck, 1995; Harrison, 1995; Tversky and Morrison, 2001). Similarly, Kesner and Linzey (2005) remarked that animation can be applied in the study of physiology, such as presenting modules covering the muscular, respiratory, urinary, cardiovascular and nervous systems.

There are claims about the advantage of using animation over traditional paper-based explanation. Lowe (2004) suggested that animations have the potential to serve both affective function and cognitive function. Affective function refers to portraying things in a humorous, spectacular, or bizarre way so that learners will be attracted to pay additional attention on the learning materials and motivated to learn.

Cognitive function refers to the clear presentation of dynamic matters (which might be abstract and difficult) that can allow learners to understand in an easier way. Compared with static images and text, animations can present procedural information (e.g. biochemical reaction steps, physiological mechanisms) more explicitly as they show the steps in an orderly manner. Hegarty (2005) mentioned that animation is used for representing the mechanical motions directly while static images could just show the motions indirectly through arrows and phase diagrams. She carried on suggesting that animations bring “more realistic representations, that is more isomorphic to the reality they represent”.
Moreover, we think animations allow representations of objects that are either too microscopic (e.g., viruses, nuclei) or even invisible (e.g., electricity current, magnetic force) for the naked eyes. Details can be viewed from angles not feasible in real life.

A number of empirical studies showed promising results animations have on learning. Trevisan, Oki and Senger (2009) compared two groups of students who used a video of traditional lecture and animation as the learning material respectively. The learning topic was about follicular dynamics, a topic in physiology. The students invited for the study were from an undergraduate reproductive physiology course in six universities in USA. An immediate one-off test was used as the evaluation instrument. The results in general showed that those used animation as the learning material got significantly higher marks.

Hays (1996) reported a study of using three different media: animation, static graphs, and textual material. They were for students to learn the movement of molecules, the effects of heat and pressure on molecules movements, and how molecule diffused from different concentrations. Students were divided into groups of high and low spatial ability and they were asked to use the three different media to learn. A test was administrated at the end to compare the learning performance of students in each group. The results showed that animation was effective to help students who were low in spatial ability.

There are, however, limitations concerning with the use of animations in teaching and learning. Designing and developing quality animations for teaching and learning can be challenging. Morrison, Tversky, and Betrancourt (2000), for example, remarked that fast-paced animations would impose difficulties to the students in observing detailed procedural information. Moreover, animations are costly and time-consuming to make. Viewing them may be time-consuming too. If a concept can be understood using a static diagram or using text, it will be time-saving.

Kesner and Linzey (2005) found no improvement on students’ learning in using animations. A learning package was developed for students to learn physiology. Animations were an important component of the learning package. The students were studying courses of human anatomy and physiology in a university in Midwestern USA. The materials were used as a supplementary learning material. The time students spent on using the learning package and their examination results were compared. The result was that use of the package “did not have a significant impact on student performance” (Kesner and Linzey, 2005: 211).

Morrison, Tversky, and Betrancourt (2000) reviewed more than 12 previous studies that were about the comparison of static graphics and animations, with follow-up tests/ tasks scores as indicators. They concluded that real benefits (in terms of student scores) of animations to learning were not found in at least four of the studies. Even for the studies that students who used animations outperformed those who did not, Morrison, Tversky, and Betrancourt thought that the benefits were not a result of animations alone but were a combination of the followings: The animations contained additional or important information, while the static graphics did not (in the studies of Large, Beheshti, Breuleux and Renaud, 1996; Rieber, 1990, 1991a, 1991b); the number of static graphics used was not enough since the molecular steps of the processes were not shown (in the studies of Park and Gittelman, 1992; Lee, 1997); or the method of study was not well designed (in the study of Kieras, 1992).

In this study, it is considered that a comparison of animations with text/ pictures will not be meaningful in the actual teaching and learning context because animations are always used as supplementary learning materials in the real setting. The research focus of the present paper, therefore, is on following:

- What are the roles of animations in supplementing learning?
- How should teachers and courseware developers attend to the various design features of animations and improve them, for bringing more learning benefits to students?

2. Our study background

Our students are students in a foundation physiology course in The Chinese University of Hong Kong. Students taking this course are majors in a range of disciplines: Pharmacy, Medicine, Chinese Medicine, Human Biology and Nursing. Almost all of the students are year 1 students. It was expected
that animation would be a good tool for learning many physiology concepts as many topics in this field of study are complex, occurring at the molecular level which is not observable, and involving multiple steps and/or multiple components, such as the working mechanisms of electrical signal generated in the nerve cell, contraction and relaxation of skeletal muscle fibers and reabsorption of water in different segments of the kidney tubules.

Starting in 2008, with the support of Courseware Development Grants, four online animation modules have been developed on topics in action potential (AP), skeletal muscle contraction (SMC), cardiovascular physiology (CP) and urine formation in kidney (UK). The animations served as supplementary learning materials primarily for students’ self-study at home. Some animations were also chosen and also played during lectures to reinforce key physiological concepts before students spend time reviewing the animation module again at home.

These animations were used by twelve classes of full-time students in two stages (four years in total) who took the physiology course. In Stage 1 (2008–2009 and 2009–2010) the animations were used as supplementary learning materials in eight classes. Students’ comments and suggestions about the animation courseware were collected for the research team and the teacher to learn about the effectiveness and usefulness of the animation courseware. The courseware was then slightly modified according to some useful suggestions from students, and was then adopted in four classes in Stage 2 (2010–2011 and 2011–2012). Stage 2 served as a follow-up study of the effectiveness and usefulness of the animation courseware, as to let the teacher and the research team to confirm factors that influence learning effects of animations.

Great care has been paid to the designs of the animations to maximise the learning potentials of these supplementary learning materials and make our effort worthwhile. Pedagogical and technical services from the Centre for Learning Enhancement And Research (CLEAR) and Information Technology Services Centre (ITSC) have been used. Significant effort has also been paid to evaluate the materials through surveying the students and meeting some of them over the four years of use.

Mayer (2002) proposed a cognitive theory model in order to explain the effects of multimedia materials on learning. In this model, cognition performs in the following ways: dual channel assumption (learner processes visual and auditory information through separate channels), limited capacity (learner's working memory is limited that he can only process in each channel at one time) and active processing (learning is the process of the learner's integrating the information received with other information). Based on these assumptions and supported with empirical evidence, Mayer carried on and made the following suggestions for an effective learning material.

- Giving explanations/remark next to the image instead of far away from the image;
- Providing narration to the animation simultaneously instead of successively;
- Eliminate extraneous words, pictures and sounds;
- Using pictures and words are better than words alone;
- Animation with narration is better than animation with words;
- Animation with narration only is better than animation with narration and words;
- Allowing students to have prerequisite knowledge about the objects in the animation at first is better than without such knowledge;
- Telling students the summary or letting them know “how the ideas are organized into a causal chain” (p. 128) is better without that;
- Present the words in conversational style is better than formal style.

The following table is about how our animations in both stages corresponded to these features. Figure 1 shows the layout of one of our animations (AP module) and illustrates how these considerations influenced our animations.
Table 1: Mayer’s (2002) nine features and the fulfillment of our animations

<table>
<thead>
<tr>
<th>Feature</th>
<th>Do our animations fulfill this feature?</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i). Giving explanations/remark next to the image</td>
<td>Yes, there are labels next to the objects in the animations.</td>
</tr>
<tr>
<td>(ii). Providing narration to the animation simultaneously</td>
<td>The animations are narrated (learners can alternatively choose to mute narrations).</td>
</tr>
<tr>
<td>(iii). Eliminate extraneous words, pictures and sounds</td>
<td>Yes, the animations are concise.</td>
</tr>
<tr>
<td>(iv). Animation with narration is better than animation with words</td>
<td>Yes, narrations are provided.</td>
</tr>
<tr>
<td>(v). Animation with narration only is better than animation with narration and words</td>
<td>Words are considered to be necessary as the scripts contain key terms students need to know. The scripts of the narrations are also displayed concurrently as captions on the screen. The design is to suit students with different learning preferences and abilities.</td>
</tr>
<tr>
<td>(vi). Allowing students to have prerequisite knowledge about the objects</td>
<td>Difficult terms are further explained in glossaries. Students can pause the animation at a point of difficulty and check for more explanations of the key terms.</td>
</tr>
<tr>
<td>(vii). Telling students the summary</td>
<td>Students are also given a sense about how the current step being viewed is situated in the overall model through a timeline represented concurrently on the screen. It is thought this design assists in understanding of the whole issue at hand.</td>
</tr>
<tr>
<td>(viii). Present the words in conversational style</td>
<td>Effort has been paid to use easy English.</td>
</tr>
<tr>
<td>(ix). Using pictures and words are better than words alone</td>
<td>Yes.</td>
</tr>
</tbody>
</table>

Figure 1: Screen capture of the AP module

Apart from the above considerations, we also took effort to ensure that:

- The animations are professionally prepared: colourful, high-quality images that are attractive to the viewers and motion of components at molecular level that are also run smoothly. It is aimed at providing visualisation of complicated molecular processes with clearer and graphically richer features when compared to text or static graphics.
- Students have full control of how the animations are played – through using the VCR-type button controls or through using the sliding bar. In this way, a certain step in the processes in the animations can be played slowly, paused, revisited or skipped depending on the needs of individual learners.
- Students can view them in any sequence they like. There is no prescribed learning path.
- Students are constantly checked for understanding with built-in exercises. The exercises are auto-corrected and students are given immediate feedback on their performance.
3. Evaluation

Students’ perceptions of the use of animations were obtained by administrating surveys and focus-group interviews which provided both qualitative and quantitative data for our study. Table 2 explains the exact animations used in each of the classes over the two stages in the four year period and the evaluation data collected in each class.

Table 2: Types of animations used and the evaluation strategies used in each class

<table>
<thead>
<tr>
<th>Note:</th>
<th>NRS = Nursing; PHA = Pharmacy; CHM = Chinese Medicine; BIO = Human Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discipline</td>
<td>NRS</td>
</tr>
<tr>
<td>No. of replies</td>
<td>184</td>
</tr>
<tr>
<td>No. of surveys distributed</td>
<td>195</td>
</tr>
<tr>
<td>AP</td>
<td>✓</td>
</tr>
<tr>
<td>SMC</td>
<td>✓</td>
</tr>
<tr>
<td>CP</td>
<td>✓</td>
</tr>
<tr>
<td>UK</td>
<td>✓</td>
</tr>
<tr>
<td>Survey</td>
<td>✓</td>
</tr>
<tr>
<td>Interview</td>
<td>✓</td>
</tr>
</tbody>
</table>

The survey was consisted of two parts: Likert-scale questions and open-ended questions. A total of 913 students (out of 1066 students, response rate being 86%) replied the surveys over the four years in the twelve different classes.

For the focus-group interviews, an invitation was sent to all students who took the course in the academic year 2009–2010 (Stage 1). Participation was voluntary. A total of 12 students accepted the invitation and three focus-group meetings was held in May and June 2010. They were students from three disciplines: Human Biology (6 students), Chinese Medicine (5 students) and Nursing (1 student). A list of simple interview questions (protocol) was prepared to guide the interviews. They were about students’ perceived effectiveness of using animation to learn, choice of animations or text for study, and suggestions for improvements. A list of simple interview questions were prepared for the interview, they were about students' perceived effectiveness of using animation to learn, choice of different learning media, the improvements of the animation(s) they wished, and other opinions. These questions were guiding questions for the interviewers rather than rigid prescribed structure of the interviews. The interview was taken in a natural approach that students were encouraged to comment freely on the use of the four animations for learning the topics, and suggest what could be improved in the animations. The students attended our interview at three different times (Table 3).

Table 3: Interview date, time and participants

<table>
<thead>
<tr>
<th>Date and time</th>
<th>1st interview</th>
<th>2nd interview</th>
<th>3rd interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants and their backgrounds</td>
<td>6 students, Chinese Medicine</td>
<td>5 students, Human Biology</td>
<td>1 student, Nursing</td>
</tr>
</tbody>
</table>

4. Findings

4.1 Stages 1 and 2

In the focus-group interviews conducted at the end of Stage 1, students had the opportunity to elaborate on how animations had assisted in their learning. The students in the three groups in general perceived that the strengths of the animations were clear presentations of the topic content, and therefore it would facilitate understanding of the topics. The followings were the summary of their comments and some quotations.
Students mentioned that it would be more explicit to present procedural information, processes that involved many interactions and dynamic changes by animation that involved many steps, such as some periodical changes (the thickness change of the uterus), the movement of ions (in the topic of counter-current in kidney), ion movement in ion channel in the topic of action potential and the topic about how hormones function. Moreover, easier memorisation of content was also the advantage of animation. Students also remarked that graphics in animations were better than book as they were colourful while many images in books were black and white which was difficult to perceive. The following are some quotations:

- “The (dynamic) graphics showed the steps in process clearly, for this aspect they were better than text and the teaching during lesson”
- “It is good to have animations as a supplementary tool for our learning of complicated process in human body such as the mechanism of filtering wastes in blood by kidney. That process involved many steps, components (ions coming in and out), and flows of fluid.”
- “Animation is most needed for mechanisms in physiology that are complicated, for example the ion channel in action potential.”
- “Some physiology topics involve too many types of hormones and interactions. This was quite confusing. Presenting them with animation will be a good practice”
- “I just partially understood the process of osmolarity change (in the topic of kidney) during lesson but fully understood after I had viewed the animation … Although there were figures in textbook that showed the value changes of osmolarity in kidney, such changes were still difficult to perceive. I just noted they were discrete changes but not trends of changes”

Students also elaborated on what topics had been challenging to them could be good candidates for our future work.

- “It would be better to have animations as a supplementary tool for our learning of complicated process in human body such as the mechanism of filtering wastes in blood by kidney. That process involved many steps, components (ions coming in and out), and flows of fluid.”
- “Some physiology topics involve too many types of hormones and interactions. This was quite confusing. Presenting them with animation will be a good practice.”

However, although students tend to agree that the graphics in animation looked good, they did not find animations had a strong effect on learning motivation.

- “It was certain that no matter how attractive the animation was, the motivation effect would not be strong, especially when compared with examination. Moreover, good personal mood should be a more important factor for learning than the provision of animations”
- “I think I was a bit interested in the animation, however, I do not think animation would be a major factor for students’ interest of learning. I think learning interest is intrinsic”

Lastly, students gave a few short suggestions on the improvements of the animations:

- “Speed to play the animation: all students thought the playing speed was too slow that it needed more time to view, and they suggested making them faster”
- “Add some translations for the difficult terms”
- “Some students suggested adding more topics for animations (e.g. brain, gastro-intestinal tract, endocrine system)”
- “Add exercises in the animations”
- “Animations provided were not informative enough. For example, the explanations of some terms could not be found in animations”

Similar remarks about improvement ideas were also collected in Stage 1 from an open-ended question in the survey. Some of these remarks were:

- To develop more of similar learning tools for other topics as well (mentioned in 10 out of the 62 replies (16.2%) in 2008–2009 and 7 out of the 43 replies (16.3%) in 2009–2010);
- Some students thought the running was slow such as long loading time, slow speed of narration (mentioned in 13 out of the 39 replies (33.3%) in 2008–2009 and 9 out of the 31 replies (29.0%) in 2009–2010);
Difficult to access/open the animation (mentioned in 8 out of the 39 replies (20.5%) in 2008–2009 and 1 out of the 31 replies (3.2%) in 2009–2010);

To provide more references to let students learn more or to facilitate students with less biology knowledge to understand the content (12 out of the 44 replies (27.3%) in 2008–2009; 7 out of the 34 replies (20.6%) in 2009–2010).

Data collected in Stage 1 thus on the whole confirmed the learning benefits of animations. There were also rooms for improvement and some of them were dealt with in Stage 2 (2010–2011 and 2011–2012).

One of the main changes was the addition of extending reading of the topic of the animations. As an example, Figure 2 shows how ‘tubular reabsorption’ is explained in fuller details on separate pages rather than within the animation.

![Figure 2: Screen capture of a section page in the modified UK module in Stage 2](image)

The more details added could serve two purposes: to allow students to get a general understanding of topic concepts by skimming through the text first, before they view the animation; and to allow students to learn more in detail after they have viewed the animation.

Captions and explanations appearing together with the animations were still important as they served to foster understanding during the time of viewing the animations. The text, however, was downsized to avoid too much overlapping with the added content. We acknowledged that, as noted by Mayer’s (2002), explanations or remarks should be placed next to the image instead of far away from the image. Moreover, results in some empirical studies also echoed Mayer’s point. For example, Holsanova, Holmberg and Holmqvist (2009) reported a study carried out with 31 Swedish people as the subjects. The study was to investigate whether different spatial arrangement of text and image would cause different cognitive load. The first setting was that the texts and images placed far away from each other while the second one was with the relevant texts and images placed close to each other. The results showed that the first setting tended to make readers more difficult to find the correspondences between the texts and the images. In another study by Harter and Ku (2008), 98 sixth-grade American students were randomly assigned learning materials of different spatial arrangements of relevant messages. The result showed that students assigned materials of relevant messages put closed together had higher gains in scores.

4.2 Overall data

The quantitative data collected in the surveys among the two stages (the four academic years from 2008 to 2012) were promising in general. Table 4 shows students’ replies in two of the questions that best represent our main objectives in developing the animations: clearer explanation of the concepts and students’ better understanding as a result of the additional resources. Students stated how much they agreed to the achievement of these benefits on a 5-point Likert scale Scores, with ‘1’ being strongly disagreed and ‘5’ being strongly agreed.
As you can see from Table 4, students’ ratings of many items on the questionnaire approached 4. The perceived learning outcomes of the animations were also to a large extent confirmed: concepts were explained clearly (overall score is at 4.0) and students remarked animation improved their understanding of the various topics (range of overall scores is at 3.9–4.1).

Table 4: Quantitative data of students’ perception to the use of animation on learning the physiology topics

<p>| Note: NRS = Nursing; PHA = Pharmacy; CHM = Chinese Medicine; BIO = Human Biology |
|----------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|</p>
<table>
<thead>
<tr>
<th>Stage of our study</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic year</td>
<td>NRS</td>
<td>PHA</td>
<td>CHM</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Disciplines</td>
<td>NRS</td>
<td>PHA</td>
<td>CHM</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>No. of replies</td>
<td>184</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td>No. of surveys distributed</td>
<td>195</td>
<td>30</td>
<td>31</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Animations explained concepts clearly?</td>
<td>3.9</td>
<td>3.8</td>
<td>4.0</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Exercises improved understanding?</td>
<td>3.9</td>
<td>3.9</td>
<td>4.0</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Animations improved understanding towards action potential</td>
<td>3.8</td>
<td>3.7</td>
<td>3.8</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Animations improved understanding towards skeletal muscle contraction</td>
<td>3.8</td>
<td>3.5</td>
<td>3.9</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Animations improved understanding towards the intended topics</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Students’ open-ended replies on the surveys also echoed the same positive attitudes towards the animation courseware. For example, students mentioned many advantages of the animations and the key ones were:

- Animations sparked students’ interest to learn (mentioned in 11 out of the 48 replies (22.9%) in 2008–2009 and 6 out of the 21 replies (28.6%) in 2009–2010);
- Animations improved students’ understanding of concepts (mentioned in 10 out of the 48 replies (20.8%) in 2008–2009, 5 out of the 21 replies (23.8%) in 2009–2010, 15 out of the 73 replies (20.5%) in 2010–2011 and 27 out of the 101 replies (26.7%) in 2011–2012);
- Animations provided clear explanations on the subject matters (mentioned in 16 out of the 121 replies (13.2%) in 2008–2009, 12 out of the 71 replies (16.9%) in 2009–2010, 31 out of the 73 replies (42.5%) in 2010–2011 and 31 out of the 101 replies (30.7%) in 2011–2012);
- Other minor advantages mentioned by students in the two stages included convenience for self-studying the topics, allowing a better efficiency of learning, enabling a self-controlled mode of learning due to the feature of the animation (e.g. can re-play and pause the animation), checking their understanding of the topic and good for revision.

Certainly, there can be some possible improvements in the future, by considering the following comments about the modified version of the animation in Stage 2:

- Some students thought the running was too fast (mentioned in 6 out of the 31 replies (19.4%) in 2010–2011 and 5 out of the 44 replies (11.4%) in 2011–2012);
The animation was not informative enough, such as explanation to answers, summaries, detailed explanations about the concepts, etc (18 out of the 38 replies (47.4%) in 2010–2011, 6 out of the 44 replies (13.6%) in 2011–2012);

Not enough function (9 out of the 31 replies (29%) in 2010–2011).

5. Discussion

5.1 Role of animations as learning resources

The feedback collected from students in general confirmed that animations are beneficial to learning. The quantitative data indicated that animations were a good media to explain concepts more clearly, and to improve understanding of the content of topics, as to students’ perception. In the quantitative data, students pointed out that animations were particularly helpful in explaining complicated and dynamic concepts which were otherwise difficult to represent through mere text or static images. In addition, some students mentioned that they became more interested in learning, and the animations facilitated memorizing of content.

The advantages of clear presentation of procedural information of animations, however, did not mean that they were superior learning media. When students were asked to take animation or learning materials with static interfaces such as textbook and PowerPoint slides as their first choice of learning medium, students gave different answers. About half of the students selected animation as their first choice of learning medium, while others preferred static media more. The former type of students reasoned that the animations were not informative enough. For example, the explanations of some terms could not be found in animations but could be found in notes or textbooks. If they view animation first, they would not able to understand some terms. They therefore put forward that their comment practices were to read notes first, to get a perception of the topic in brief, then view the animations, and followed by reading books. More topic content was added in the animations in Stage 2 as for improvement.

There had been worries that animations may represent actions in high speed such that perception of the procedural changes in processes can be difficult (Morrison, Tversky, and Betrancourt, 2000). Such worries were not found in our study. It may be because this study is to emphasise on the supplementary function of animations. Animations assist in the descriptions of concepts on the traditional media rather than acting as a replacement for the traditional media. In addition, the animations can be made to be easily plausible and repeatable through controlling the scroll-bar. The interface allows students to pause and think before going on to the next step.

5.2 Design features and improvement

Considering students’ feedback on the aspects they liked best and the areas they would like to have improvement, it was summarised the following points for the design and application of animations for more learning benefits.

- Explanations should be rich and clear (translation may be necessary) so that the animations are self-sufficient learning resources.

- There should be a good balance between clear presentation and beautiful interface, enough function and the speed of running/loading of the animations.

- Animations are better media for certain types of topics: for example, dynamic concepts involving movement of tiny components, or actions that involve complicated interactions different parts. Care is needed to spend effort in the most needed scenarios.

6. Conclusion

In this project, animations were developed as supplementary learning resources for students in a physiology course for challenging and dynamic concepts that are difficult to represent on text and static images. 913 students used all or some of the animations in twelve different classes of the same course over a period of four years (in two stages). Perceptions of students in Stage 1, collected through surveys and focus-group interviews, were positive and demonstrated that animations could explain complicated contents more explicitly to students and there was a great student demand for similar learning tools for other challenging topics in the discipline as well. Our earlier experience tended to show that animations are good supplementary learning materials for students particularly
for learning of complicated concepts. Our effort in Stage 2, however, seemed to indicate that animations, with close integration with extended readings, can be good in facilitating learning (e.g. better understanding, sparking students’ interest of learning) of the subject matter as well.

Acknowledgements

The animation courseware in this study was supported by Teaching Development Grant of The Chinese University of Hong Kong.

References


An Innovative Research on the usage of Facebook in the Higher Education context of Hong Kong

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Abstract: Teaching and learning is undergoing a dramatic change due to the advancement in telecommunication and IT. Increasingly, online learning platform is playing an important role higher education. The maturity of Internet and emergence of various cloud services catalyse the development of these platforms and student learning behaviour. An example is Facebook, online social network sites, which changes the interaction, communication and interrelation of students and their daily life. There is a growing trend that people participate in Facebook. The phenomenon enables teachers to think whether Facebook can be incorporated in teaching so as to facilitate student learning. Past research on online social network sites evidence that there are a number of benefits including the improved student participation, social relationship, interaction, communication and facilitation. However, seldom studies try to consolidate these benefits and examine simultaneously against the overall learning motivation. This study attempts to develop a model of student motivation in learning with four Facebook benefits: (1) Interaction, (2) Communication, (3) Social relationship, (4) Participation. The students of the School of Continuing and Professional Studies (SCS), The Chinese University of Hong Kong (CUHK), studying Hi-Diploma Programme, are invited to participate in this study. A survey was conducted to examine how these Facebook benefits relate to student motivation in learning. The results revealed that Interrelationship, Communication, Social relationship, and Participation influence significantly on student learning motivation. The results show teachers how Facebook benefits improve student learning motivation. The study also tries to explore some demographic trend in related to student Facebook usage.

Keywords: student motivation, online social network site, Facebook, online learning platform

1. Introduction

There is an increasing trend that online learning platforms are becoming important in teaching and learning (Volery & Lord, 2000). And these online learning platforms provide comprehensive to functions in teaching and learning. However, the maturity of Internet facilitates the development of different social or community services which are widely accepted by students. This results in students willing to spend hours on these services rather than the online learning platforms. An obvious example is Facebook, a social networking service and website launched in February 2004 (Eldon, 2008). The emerge of social networking service create a new paradigm of Internet usage. Facebook is widely adopted by people all round the world and the number of user increases over time (Nathan & Jessica, 2011). According to the ‘Facebook Statistics, Stats and Facts for 2011’, over 700 billion minutes a month are spent on Facebook, 20 million applications are installed per day and over 250 million people interact with Facebook from outside the official website on a monthly basis, across 2 million websites. The core 18-24 year old segment is now growing the fastest at 74% year on year. Almost 72% of all US internet users are on now Facebook, while 70% of the entire user base is located outside of the US (http://www.digitalbuzzblog.com/facebook-statistics-stats-facts-2011/).

People are increasingly using Facebook for communication, social network and interaction. Using Facebook becomes part of a routine. Students use Facebook frequently to communicate and interact with friends and classmates (Adam, 2008) where as they may spend hours in there (Zhao, Sherri & Jason, 2008). Even though online learning platforms provide the discussion forum and messaging features, students prefer discussing and communicating on Facebook. In order to motivate student learning, some teachers are trying to make use of Facebook in teaching and learning (Mazer, Murphy & Simonds, 2007). Past studies investigate various benefits of Facebook including the social benefits (Ellison, Steinfield & Lampe, 2007; Zhao, Sherr & Jason, 2008; Adam, 2008; Morris & Millen, 2007), student perception on various social aspects (Special & Li-Barber, 2012; DeSchryver, Mishra, Koehleer, & Francis, 2009; Hewitt & Forte, 2007), student learning attitude, social relationship and learning environments (Mazer, Murphy & Simonds, 2007). However, seldom studies try to consolidate these benefits and how these benefits influence student motivation in learning through incorporating Facebook in teaching.
2. Prior studies and hypotheses development

2.1 Student motivation in learning

Student motivation naturally has to do with students' desire to participate in the learning process (Brophy, 1987). There are two different types of student motivation, namely the intrinsic and extrinsic student motivation. Intrinsic motivated student participates in an activity 'for its own sake, for the enjoyment it provides, the learning it permits, or the feelings of accomplishment it evokes' (Lepper, 1988) whereas extrinsic motivated student performs "in order to obtain some reward or avoid some punishment external to the activity itself," such as grades, stickers, or teacher approval (Lepper, 1988). Thus, even though they are equally motivated to participate in an activity, the origin or focus of their motivation are different. However, Marshall (1987) pointed out that there were slight difference between 'student motivation' and 'motivation to learn' which meant the meaningfulness, value, and benefits of academic tasks to the learner--regardless of whether or not they are intrinsically interesting. Besides, Ames (1990) further explained 'motivation to learn' was featured by long-term, quality involvement in learning and commitment to the process of learning.

Student motivation in learning is important to student learning success (McCombs & Whisler, 1997). There is a positive correlation between student motivation and academic achievement (Ames & Archer, 1988; McCombs & Whisler, 1997) There are a number of activities that can improve student motivation. This includes the environments for close interactions between teacher and student; close on-campus friendships and motivation in school-sponsored activities; class discussion and involvement with teacher in academic community; extracurricular involvement; academic work & experience; and interaction with peers (Pascarella & Terenzini, 2005). Gray & Daymond (2010) argued that in the course of academic achievement, student motivation is needed in order to reach academic achievement. Though, student motivation is found critical to student success, the majority of studies are taken place in blended classroom or online environment (Doolan, Hilliard & Thornton, 2006; Doolan, 2006) rather than social networking platform like Facebook.

2.2 The benefits of using Facebook

Many researchers have identified important variables dealing with Facebook. We examine four benefits: (1) interaction, (2) Communication, (3) Social relationship, (4) Participation.

Unlike tradition classroom interaction, online social networking site, such as Facebook, are not bounded by time and space constraints but these platforms do no provide traditional face-to-face communication. Thus, teachers become the facilitators and intermediaries between students and resources (Bower, 2001). The teacher is like a learning catalyst and knowledge navigator for students (Lammintakanen & Rissanen, 2005). Teachers should be active and interactive sufficiently to show their participation and involvement online (DeSchryver, Mishra, Koehler & Francis, 2009). Teachers roles changes when participating in online learning environments such as Facebook and communicating with students in order to establish the relationship and motivate students in learning (Mazer, Murphy & Simonds, 2007; Doolan, 2011). Thus, both teachers and students can benefit from the interaction facilitated by Facebook. This can be achieved through monitoring student progress; identifying student learning difficulties; motivating student to learn; giving advice to students in learning (Mazza & Dimitrova, 2004) as well as timely responses (P.-C. Sun et al., 2008).

A reliable online platform can facilitate the communication and interaction between teacher and student and also allow student to download learning materials and submit assignments. Thus, It is also crucial to learning success because an ease-of-use system improves student usability in terms of effectiveness, efficiency and satisfaction (Roblyer & Ekhaml, 2000), system representation (Romero, Du Boulay, Cox, Lutz & Bryant, 2007), easy-to-use interface design (Sun et al., 2008), user-friendliness (Holsapple & Lee-Post, 2006) and allow personalization (Picolli et al., 2001).

When students are given a course-related online platform to access, students should be confident and able to use online technologies (Webster & Hackley, 1997). Students should also make up their mind to use new technology (Levy 2003; Lammintakanen & Rissanen, 2005), be motivated to learning (Palloff & Pratt, 1999) and have a positive attitude toward computer and Internet (P.-C. Sun et al., 2008).
Hypothesis 1: The interaction benefit in Facebook should positively influence student motivation in learning

Hypothesis 2: The communication benefit in Facebook should positively influence student motivation in learning

Hypothesis 3: The social relationship benefit in Facebook should positively influence student motivation in learning

Hypothesis 4: The participation benefit in Facebook should positively influence student motivation in learning

The proposed model of student motivation in learning and Facebook benefits is shown in Figure 1.

The purpose of the study and research questions

Authors argue the social benefits of Facebook (Ellison, Steinfield & Lampe, 2007; Zhao, Sherri & Jason, 2008; Adam, 2008; Morris & Millen, 2007), student perception on various social aspects (Special & Li-Barber, 2012; DeSchryver, Mishra, Koehler, & Francis, 2009; Hewitt & Forte, 2007) and student learning attitude, social relationship and learning environments (Mazer, Murphy & Simonds, 2007). Though there is past study about Facebook benefits and student motivation, its focus is about the frequency of Facebook activities and student motivation. Besides, regarding the past literature on the area of student motivation, extensive research are studied in classroom environment or about face-to-face activities (Pascarella & Terenzini, 2005; Kuh, 2009; Azevedo, F. S., et al., 2012). Seldom studies focuses on relating student motivation to social networking service. This study attempts to fill this research gap and propose a conceptual model. Thus, this comes to the research question:

What do the benefits of Facebook influence student motivation in learning?

4. Research methodology

4.1 Measurement development and pilot test

We conducted a number of in-depth interviews with various students of the School of Continuing and Professional Studies (SCS), The Chinese University of Hong Kong (CUHK) to examine the validity and reliability of our research model. Then, we developed the student questionnaire based on the survey instruments from the literatures and feedback from interviewees. The questionnaire was revised by teachers with significant experiences in implementing both online learning platform and Facebook in teaching. The questionnaire contained 7-point Likert scale questions from [1] strongly disagree to [7] strongly agree. A pilot test of the instruments was conducted with 43 students of Hi-Diploma programme, including corporate management and business information system; and mobile and network computing, where they were given both online learning platform and Facebook to use throughout the 15 week semester.

4.2 The course arrangement

Six classes of CUHK-SCS Hi-Diploma students (Total: 312) were arranged to access the MOODLE, online learning platform, and Facebook, social networking service for the 15 week semester. Students were required to download the course materials, submit assignments, and do the quizzes via MOODLE. Additionally, students were required to join a private study group on Facebook created by teachers in the beginning of the semester. Students were also required to participate in Facebook by...
submitting individual & group case study on the Wall of the private group; answer quick quizzes; and prepare group presentation video clip and upload to the group for peer feedback. On the other hand, teachers were required to answer student questions posted on Facebook promptly, update students any news or supplementary resources using Facebook frequently.

4.3 Data collection

The data were collected from the CUHK SCS Hi-Diploma student’s in-class. A total of 312 surveys were distributed at the end of the semester. The sampling method was convenient sampling where students were invited to participate in the survey where they were required to read and sign the survey consent form about the purpose of survey, the benefits and risks of participating in the survey. A total of 284 students returned the questionnaires. This resulted in a response rate of 91.0%. Table 1 shows the demographic profile and descriptive statistics of the respondents.

Among the 284 respondents, 201 (70.8%) of them were male whereas 83 (29.2%) were female. There were 219 (77.1%) students with age ranged from 18 - 21 whereas the rest of 65 (22.9%) students were mature students. In terms of Facebook usage, There were 14.8%, 17.6%, 13.7%, 16.2% of students spending less than 1hr, 1-2 hrs, 2-3 hrs and 3-4 hrs respectively. There were only 9.9%, 9.5% of students spending 4-5 hrs and 5-6 hrs respectively. However, there was 18.3% of students spending more than 6 hrs on Facebook.

In this research, the Statistical Package for the Social Sciences version 12 (SPSS v.12.0) was used for statistical analysis. The collected data was analyzed using multiple regression analysis. There were 4 variables, namely, (1) Interaction [B1], (2) Communication [B2], (3) Social relationship [B3], (4) Participation [B4] are used as the regressors and the students motivation in learning as regress.

Table 1: The demographic profile and descriptive statistics of the respondents (n=284)

<table>
<thead>
<tr>
<th>Measure and items</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>201</td>
<td>70.8</td>
</tr>
<tr>
<td>Female</td>
<td>83</td>
<td>29.2</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 - 21</td>
<td>219</td>
<td>77.1</td>
</tr>
<tr>
<td>22 - 25</td>
<td>51</td>
<td>18.0</td>
</tr>
<tr>
<td>26 - 29</td>
<td>10</td>
<td>3.5</td>
</tr>
<tr>
<td>30 - 33</td>
<td>4</td>
<td>1.0</td>
</tr>
<tr>
<td>Facebook usage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 1 hr</td>
<td>42</td>
<td>14.8</td>
</tr>
<tr>
<td>1 - 2 hrs</td>
<td>50</td>
<td>17.6</td>
</tr>
<tr>
<td>2 - 3 hrs</td>
<td>39</td>
<td>13.7</td>
</tr>
<tr>
<td>3 - 4 hrs</td>
<td>46</td>
<td>16.2</td>
</tr>
<tr>
<td>4 - 5 hrs</td>
<td>28</td>
<td>9.9</td>
</tr>
<tr>
<td>5 - 6 hrs</td>
<td>27</td>
<td>9.5</td>
</tr>
<tr>
<td>More than 6 hrs</td>
<td>52</td>
<td>18.3</td>
</tr>
</tbody>
</table>

5. Data analysis

5.1 Collinearity

Multiple regression analysis is used to test the significance of variables. Besides, in order to avoid any violation with the basic assumptions underlying the least squares method used by the linear regression model, P-P plot was conducted to assess the assumption of normality. The plot showed that the quantile pairs fell nearly on a straight line. Thus, it is reasonable concluding that the data used in this research are approximately normal. Then, this research used the VIF to assess the multicollinearity among independent variables in the model. As shown from the table 1, the tolerance and VIF values of all independent variables (1) to (4) were within the range (Tolerance > .2 and VIF <
4) that has no severe multicollinearity problem among the regressors. At last, we used the Durbin-Watson d statistic to detect serial correlation. The value of 1.972 (less than 2) indicated that autocorrelation problem does not exist (Gujarati, 2003). Table 2 shows the Collinearity Statistics

**Table 2: Collinearity statistics**

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Tolerance</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction [B1]</td>
<td>.314</td>
<td>2.541</td>
</tr>
<tr>
<td>Communication [B2]</td>
<td>.418</td>
<td>2.139</td>
</tr>
<tr>
<td>Social relationship [B3]</td>
<td>.276</td>
<td>3.246</td>
</tr>
<tr>
<td>Participation [B4]</td>
<td>.337</td>
<td>2.522</td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td>1.972</td>
<td></td>
</tr>
</tbody>
</table>

Dependent variable: Student motivation in learning

### 5.2 Reliability and validity analysis

The questionnaires were presented to several experts to improve face and content validity. Reliability was examined using Cronbach's α values for each variable. As shown in Table 3, the values of four variables were above .72, which is a commonly acceptable level. The reliability of B1=.86; B2=.88; B3=.85; B4=.89; and SML=.80.

**Table 3: Descriptive statistics, correlation, reliabilitiesa among study variables (n=131)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Means</th>
<th>SD</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction [B1]</td>
<td>5.01</td>
<td>1.10</td>
<td>(.88)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication [B2]</td>
<td>5.10</td>
<td>1.21</td>
<td>.72</td>
<td>(.92)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social relationship [B3]</td>
<td>4.78</td>
<td>1.25</td>
<td>.73</td>
<td>.60</td>
<td>(.89)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participation [B4]</td>
<td>4.68</td>
<td>1.40</td>
<td>.69</td>
<td>.57</td>
<td>.78</td>
<td>(.93)</td>
<td></td>
</tr>
<tr>
<td>Student Motivation in Learning [SML]b</td>
<td>4.79</td>
<td>1.26</td>
<td>.70</td>
<td>.71</td>
<td>.82</td>
<td>.85</td>
<td>(.85)</td>
</tr>
</tbody>
</table>

Reliabilities (Cronbach's α) are in parentheses.

Dependent variable: SML

### 5.3 Pearson correlation analysis

In terms of the correlations between variables, B4 (r=.93, p<.001) has the highest correlation to the dependent variable. The B2 (r=.92, p<.001) has the 2nd highest correlation to the dependent variable. Then it is followed by the B3 (r=.89, p<.001) and B1 (r=.88, p<0.001). All four variables exhibited significant relationships with student motivation in learning.

### 5.4 Hypotheses testing

This study conducted multiple regression analysis to test the hypotheses using SPSS. The four influential variables derived from previous research, i.e. B1, B2, B3, B4 were applied as independent variables, while SML was used as a dependent variable. Table 4 shows the results of the regression analysis. All four independent variables are considered to have significant relationships with student motivation in learning with p-values <.05. They are B1, B2, B3, and B4.

Hypothesis 1 examined the influence of the interaction benefit on student motivation in learning. it is supported, with p-values less than .0 and is significant. Hypothesis 2 examined the relationship between the communication benefit and student motivation in learning. It is supported where communication benefit has significant positive influence on student motivation in learning (β=1.71 , p<.01). Social relationship has positively significant effect on student motivation in learning (β=.185 , p<.05). Therefore, Hypothesis 3 is supported. Hypothesis 4 , participation benefit has a strong, significant and positive influence on student motivation in learning (β=0.465 , p<.001). Thus, Hypothesis 4 is supported.
Table 4: The results of the regression analysis

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>B</th>
<th>Beta (β)</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(constant)</td>
<td>.156</td>
<td>.525</td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>.182</td>
<td>.161</td>
<td>2.164*</td>
</tr>
<tr>
<td>B2</td>
<td>.121</td>
<td>.171</td>
<td>3.174**</td>
</tr>
<tr>
<td>B3</td>
<td>.173</td>
<td>.196</td>
<td>3.206*</td>
</tr>
<tr>
<td>B4</td>
<td>.364</td>
<td>.359</td>
<td>4.471*</td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td>.806(^a)</td>
</tr>
<tr>
<td>R Square</td>
<td></td>
<td></td>
<td>.650</td>
</tr>
<tr>
<td>Adjusted R Square</td>
<td></td>
<td></td>
<td>.647</td>
</tr>
</tbody>
</table>

\(^a\) Predictors: (Constant), B1, B2, B3, B4

\(^b\) Dependent Variable: (6) Student motivation in learning

Note: *. p<.05, **. p<.01, ***. p<.001

6. Discussion

6.1 An integrated model for student motivation of learning

As indicated from the results of multiple regression analysis, three of the four variables show significant and positive influences on student motivation in learning, i.e. B1, B2, B3, B4. The adjusted R square suggested that 65.0% of the student motivation in learning's variance can be explained by these three variables (F = 144.759, p<.001). The model generated from the multiple regression analysis has a reasonable level of representativeness in the selected predictor variables. The model can be presented in form of prediction formula as follows:

\[ SML = B1 \times w1 + B2 \times w2 + B3 \times w3 + B4 \times w4 + C \]

where C is constant; and w1, w2, w3, w4 are empirically determined weights.

6.2 Interaction benefit [B1]

Our findings corroborate those of Bower (2001); Lammintakanen & Rissanen (2005); DeSchryver, Mishra, Koehleer & Francis (2009). The role of teachers become the facilitators and intermediaries between students and resources on the online platform. Through interaction, the teachers help catalysing student learning and behave as knowledge navigator for students. In order to have the interaction benefit from Facebook, teachers should be active and interactive sufficiently to show their participation and involvement online. Therefore, student can be motivated to learn throughout the benefit from improved interaction.

6.3 Communication benefit [B2]

Our findings corroborate those of Mazer, Murphy & Simonds, (2007); Doolan, (2011). The role of teachers changes when participating in Facebook. They are required to actively participate Facebook social environment, which, in turn, encourages the communication among teachers and students. Hence the relationship improved and also the students motivation in learning (.Roblyer & Ekhaml (2000); Romero, Du Boulay, Cox, Lutz & Bryant (2007). The convenience of technology has significant positive influences on student motivation of learning. Since the majority of students age ranges from 18 – 21 (see Table 1), they belong to Generation Y (Eisner, 2005). From the marketing perspective, they will have large disposable income; they are comfortable with technology; they tend to be impatient and “Now-Oriented” (Armstrong & Kotler, 2006). Thus, they are willing to accept new technology as long as it is easy-to-use and convenient (Sun et al., 2008). In order to improve student learning motivation and facilitate student learning, the benefit from communication is very important.
6.4 Social relationship benefit [B3]

Our findings corroborate those of Mazza & Dimitrova (2004); Mazer, Murphy & Simonds (2007). Social relationship benefit has significant positive influences on student motivation in learning. With Facebook, students are able to have better bonding and social capital (Ellison, Steinfield & Lampe, 2007). Besides, the friendliness and openness can be significantly improved throughout this platform (Zsolnai, 2010). Therefore, the role of teachers and students is very important in building better social relationships and also the student motivation in learning (Wentzel, 1998).

6.5 Participation benefit [B4]

Our findings corroborate those of Webster & Hackley (1997); Palloff & Pratt (1999); Levy (2003); Lammintakanen & Rissanen, (2005); and P.-C. Sun et al., (2008). The benefit of participation has the strongest influence on student motivation in learning. Facebook, which are not bounded by space, location and time, allows students to access more flexibly. Therefore, students should be autonomous and self-directed (Ostlund, 2008) by improving the participation aspect. Among the four independent variables, student participation in Facebook has the strongest association with student learning motivation. From an operational point of view, it is necessary to clarify with students their role in learning, especially the importance of participation when using Facebook in teaching and learning.

6.6 Concern about using Facebook in teaching and learning

There are teachers reluctant to use Facebook in teaching and learning. Their concerns are multiple identities (Morris & Millen, 2007); privacy and security issue (Govani & Pashley, 2005); and the original purpose of Facebook as a social networking platform rather than an online learning platform. Facebook is similar to the discussion forum in online learning platform which violates the system integration and data integrity. However, these are challenges that teachers should overcome. It is because the student behaviour changes over time and the age difference (generation gap) between teacher and student increases over time (Johnson & Kardos, 2005). Teachers have their responsibilities to tackle these challenges facing them and think of innovative teaching strategies or enhanced blended approach to facilitate student achievement in learning (Lau, Lam & Zhou, 2010; Lam, 2011).

Another concern are the variation in the acceptance of Facebook (Cheung, Chiu & Lee, 2011), there are cultural difference between students in Europe and Asia. Most students in Asia are willing to accept new technology quickly than those in Europe. In other words, students in Europe are skeptical in adopting new technology. Therefore, this raise a problem of imposing the use of Facebook in teaching and learning (Prahald & Ramaswamy, 2000).

7. Research limitation

One of the major limitations of this study is that the sample size is only 284 students and is not big enough for comprehensive regression analysis. This results in evaluating four critical benefits in related to Facebook. The students participating in this research are studying CUHK-SCS Hi-Diploma programme which can only reflect the characteristics in Chinese context. Therefore, the research findings are not completely representative and cannot be generalized. However, this study provide insights into student learning motivation and the benefits of social networking service if used in teaching and learning.

However, these limitations can be improved by increasing the sample size by inviting more teachers and students of different programmes participating in this study; inviting other institutions of different countries; and increasing the scope and depth of the research area and incorporating more social network service benefits so that more variables can be identified. Hence, an comprehensive model can be established

8. Conclusion

Student motivation is one of the important factors for student learning success. This research focuses on examining how the social network service benefits influencing student motivation in learning if this service is used in teaching and learning. It is believed that Facebook is not only the social network service, its benefits can help motivate student to learn if properly incorporated in teaching and learning.
The use of Facebook as part teaching and learning is rather new. Should it be used in teaching? Some would say not especially students, it is their informal space. Afterall, students keep changing their behaviour with new technologies. The generation gap between teacher and student is increasing over time. The main issue is how to tackle and overcome the gap; and facilitate student learning. This research attempts to identify factors influencing student motivation in learning. An integrated model developed from previous studies consisting of four benefits is presented to guide research and overcome the gap.

Three of the factors, Teacher-student interaction, Convenience of technology and Student attitude toward Facebook, had significant positive influences on Student motivation in Learning. From the statistical result, 83.4% of the student motivation in learning's variance can be explained by these three variables (F = 158.68, p<.001). The model generated from the multiple regression analysis has a reasonable level of representativeness in the selected predictor variables. Among the three significant independent variables, student attitude toward Facebook has the strongest influences on student motivation in learning. This implies this factor is the most important one in engagement.

Though there are only three factors identified in this study, this study provides insights for teachers who are planning to use Facebook as part their teaching; and academics who are interested in these research areas. This study is designed and planned carefully and yet there are certain limitations. It is suggested to continue this study in order to tackle those limitations, making the future results and integrated model more representative and generalisable. Further research might incorporate more variables and investigate variance between degree or sub-degree courses students; and between different programme of students within CUHK or across institutions. However, what this research does offer is to provide insights about how student motivation in learning can be influenced using Facebook as part of online learning platform; and researchers who are interested in research areas of student engagement, online social network site, Facebook and online learning platform.

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Digital Devices in Classroom – Hesitations of Teachers-to-be

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Abstract: More and more teachers are facing the decision whether they should allow or promote students the use of technology in the classroom. The decision is difficult as there are apparently both advantages and disadvantages in doing either way. In terms of positive impacts, research revealed that the use of digital devices in the classroom setting was capable of facilitating faculty-student interactions and in-class participation, which in turn enhanced engagement and active learning (Fitch, 2004; Partee, 1996; Stephens, 2005). On the contrary, evidence was also identified to show a relationship between notebook use and distraction in class. The pilot study investigated the desirability of allowing digital devices in class in our local context, and to explore the factors that influence the success of the practice. Two studies were conducted with students in teacher-training programmes at The Chinese University of Hong Kong. In the first study, students were allowed to use computers in the lessons (free use) in the whole semester and then they were asked to reflect upon the learning benefits, if any. In the second study, the future teachers were asked to comment openly on the use of digital devices for more guided purposes such as student response system and e-textbook. Results in general revealed that it is indeed a very controversial and complicated issue. On the one hand, many positive learning benefits relating to using digital devices in class are acknowledged. On the other hand, distraction is a major concern as students may use the technology for irrelevant purposes in class. Participants thus were also very conservative about channeling the use of computers in classroom to other academic contexts. The answer to the question whether computers be allowed in class thus is not a simple yes or no but is a series of suggestions concerning when and how to do it more appropriate.

Keywords: computers in classroom, distraction

1. Digital devices in classroom

Portable digital devices such as notebook/tablet computers and handheld mobile devices such as smartphones have become almost standard equipment in tertiary education (Weaver and Nilson, 2005). These devices are also readily connected to the internet. In Hong Kong, for example, there were 14.58 million subscriptions of mobile cellular services in 2011. Taking into account that Hong Kong population was only around 7 million, the ratio was roughly one to two. Among the 14.68 million subscriptions, 5.1 of them were subscribed to broadband services (Lam & Duan, 2012).

We roughly categorized the use of digital devices in classroom into the following two main scenarios. On the one hand, there is a relatively guided use of these devices in classrooms – i.e. teachers have controlled and well-defined tasks for students to work on their computers in the classroom. For example, there is a recent interest in using e-textbook to replace paper-based textbook (Yuen, Cheung & Tsang, 2012). Wang, Shen, Novak and Pan (2009) also suggested that mobile devices can be used for instantaneous communications among teachers and students. Cobb, Heaney, Corcoran and Henderson-Begg (2010) also looked at a system that allowed students to comment on teaching through texting on mobile devices.

On the other hand, there is a comparatively free use of mobile devices in classrooms – students use the devices in the classroom for their own purposes. Salter, 2010 reported in many universities it has become a common scene that students take out and use their own digital devices for various purposes in the classroom.

The use of digital devices in classroom has attracted considerable controversy concerning its advantages and disadvantages. On the positive side, a number of studies unveiled evidence to show positive impacts of permitting digital devices in classroom. For instance, research revealed that the use of digital devices in a ubiquitous computing environment was capable of facilitating faculty-student interactions and in-class participation, which in turn enhanced engagement and active learning (Fitch, 2004; Partee, 1996; Stephens, 2005). Moreover, web-based activities increased...
overall class satisfaction and that in group projects (Driver, 2002). On top of an increase in engagement and satisfaction, Demb et al (2004), also found that students perceived that digital devices had positive impacts on their study habits and their academic success.

It was also evident that the use of digital devices in classroom was effective in enhancing motivation, the ability to apply course based knowledge, and overall academic achievement among students (Mackinnon and Vibert, 2002; Siegle and Foster, 2001). Moreover, the use of computers, coupled with wi-fi connectivity, had increased active exploratory learning and was effective in promoting interactions between students and the instructor in large classes (Barak et al, 2006). Some of these claimed were empirically supported. In a comparative study between classrooms with and without the use of computers, students from classrooms with computers reported to have participated more, to be more interested in learning, and to be more motivated to perform well (Trimmel and Backmann, 2004).

On the negative side, however, there have been worries that use of digital devices in class distracted students from learning in class. The problem seems to be more apparent in the free use scenario. Tesch, Coelho and Drozdenko (2011) conducted a study to investigate the opinions of students about whether computer use not under the guidance of teachers would result in substantial distraction. A total of 57 general potential distracting factors were identified by students such as discussion among neighbors and people coming in late for lectures. Students rated use of digital devices to be a moderately distracting factor. Hembrooke and Gay (2003) designed an experiment to explore how the use of digital devices impacted on learning performance among students. The experiment involved two groups of students who listened to exactly the same lecture in which one of them was allowed to use computers whereas the use of digital devices was forbidden in the other group. Results indicated that students who were allowed to use computers experienced decrements in the same memory test that the other group took. Similarly, Fried (2008) reported a survey study that students who spent considerable time multitasking with their notebooks were prone to decrease in self-reported understanding of course material and overall course performance. Such results were consistent with that of Grace-Martin and Gay (2001) where use of digital devices in class encouraged the conduct of non-learning usages and therefore limited or even reserved benefits in relation to academic performance. Also, the problem of maintaining attention among students in class was also reported in a number of other studies (Biggs and Tang 2007; Bligh, 2000; Chickering and Gamon, 1987; Geske, 1992; Hartley and Davies, 1978; McKeachy, 1999; Bonwell and Eison, 1991).

In fact, misuse of technology in class affected not only individuals who engaged in a particular activity but people around that individual (Mueller, 2009). Also, few teachers integrate notebooks fully into classrooms (Olson, 2002). There were extreme cases in which some of the professors were frustrated enough to unplug the wireless transmitter manually because their students engaged in non-academic activities via the internet without paying attention (Schwarz, 2003). A number of other studies also reported the presence of some kinds of frustration experienced by teachers (Kladko, 2005; McWilliams, 2005; Szaniszlo, 2006; Young, 2006).

Despite a large amount of research in the effectiveness of notebook use in overseas institutions, the study in the use of notebook in local classroom has not been extensively explored in tertiary institutions of Hong Kong. A recent study that was relevant to our local context was interesting. It compared the use of notebook in classroom among students from 36 award winning teachers in Hong Kong, Canada, and Australia. Results of the study revealed that 78 % of the students from Hong Kong reported to have used personal notebooks almost always or often in class. In comparison, only 67% of students from Canada and 60% of those from Australia reported so in the study (Salter, 2010). The results thus suggested to us that this issue of whether or how students should be allowed to use computers in class is of particular importance in our local context.

2. The study

We had the following research questions in mind: whether students engage in distracting activities as they use their digital devices in local classroom, and whether they agreed with the advantages of such practice.

Due to practical limitations, the evaluation method focused on the collection of perception data. In other words, the present study looked at people’s perceptions of computer use in classroom and its
distraction rather than they were actually doing with the computers. We were aware of the limitations of the subjective nature of the study but hoped the findings could nevertheless lead to preliminary understanding of the issue.

Two sets of data were solicited. The first study was conducted in one of the postgraduate courses in an English programme at The Chinese University of Hong Kong in 2011. It began by giving permission to the 15 postgraduate students in the course to bring in their own notebooks to one of their courses. Computers were used as both a teaching tool and self-studying tool in the course. Since the course was on computer applications in second language teaching, the teacher at times would show-how software and platforms and students could have hands-on using their own computers in the classroom. In this way, computers were actively used as teaching tools in this course (guided use). On the other hand, students were allowed to use their digital devices continually so that they could conduct information search, note-taking or any other related tasks initiated by the students themselves (free use). In order to study their views about notebook use in class, a survey was administered to all students at the end of course. The investigation consisted of a survey with a response rate of 100%. The focus of this study was more on the desirability of free use of digital devices in class.

Subjects of the second study were also future teachers. They were students studying a post-graduate certificate programme in the Chinese language teaching stream at The Chinese University of Hong Kong in 2012. Students attended a workshop on teaching and learning technologies. In the workshop, students experienced using their own mobile devices to interact with teachers on a web-based student response system called uReply. The use of eBooks was demonstrated and the possibility of using e-textbook to replace paper-based books was discussed. 19 of the students the 26 students returned the survey distributed at the end of the workshop (response rate being 73%). The focus of this study was more on the desirability of guided use of digital devices in class.

3. Findings

3.1 Study one

In the first section of the survey, participants were asked to self-report the types of tasks they used the digital devices for in the class. They were asked to remark on a pre-defined list of tasks using a 3-point scale (Frequently [3]; Occasionally [2]; Never [1]). Table 1 summarizes the engagement in activities related to course. Among the four activities that students were asked to report on, students spent most of their time with their notebooks on reading class materials (average score being 2.47). The other activities in the order of their relative frequency were taking class notes (2.29), reading web materials that are related to course content (2.27), and communicating with others (1.93).

<table>
<thead>
<tr>
<th>Activities that are related to course</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Read class materials</td>
<td>2.47</td>
</tr>
<tr>
<td>2. Take class notes</td>
<td>2.29</td>
</tr>
<tr>
<td>3. Read web materials that are related to course content</td>
<td>2.27</td>
</tr>
<tr>
<td>4. Communicate with others using computers for issues related to subject content</td>
<td>1.93</td>
</tr>
<tr>
<td>Average for item 1 - 4</td>
<td>2.24</td>
</tr>
</tbody>
</table>

Table 2 summarizes students’ engagement in activities that were not related to course. It seemed that students were not actively engaged in most of these activities as most of the ratings were around 1 to 1.8. An obvious exception was using the notebook computers to read emails (2.13).

Participants were asked to write down the approximate percentage of time that they spent on notebook working on tasks related and not related to course respectively. On the whole, students reported to have spent the majority of their time (69.96%) in class on activities that were related to course whereas the rest of time (30.36%) on activities not related to course.

In the next part of the survey, participants remarked on a 5-point scale (Strongly agree [5]; Agree [4]; Neutral [3]; Disagree [2]; Strongly disagree [1]) how much they agreed upon a list of statements
concerning advantages and disadvantages of letting students use their own computers in classroom (Table 5).

**Table 2: Mean frequency of engagement in activities non-related to course**

<table>
<thead>
<tr>
<th>Activities that are not related to course</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Read email</td>
<td>2.13</td>
</tr>
<tr>
<td>2. Send email</td>
<td>1.67</td>
</tr>
<tr>
<td>3. Read/send instant messages</td>
<td>1.73</td>
</tr>
<tr>
<td>4. Read news</td>
<td>1.47</td>
</tr>
<tr>
<td>5. Visit e-commerce sites such as Amazon and eBay</td>
<td>1.00</td>
</tr>
<tr>
<td>6. Play games</td>
<td>1.07</td>
</tr>
<tr>
<td>7. Work on assignments from other classes</td>
<td>1.47</td>
</tr>
<tr>
<td>8. Work on other things that are not related to this class</td>
<td>1.87</td>
</tr>
<tr>
<td>Average for item 1 - 8</td>
<td>1.55</td>
</tr>
</tbody>
</table>

Participants were asked to write down the approximate percentage of time that they spent on notebook working on tasks related and not related to course respectively. On the whole, students reported to have spent the majority of their time (69.96%) in class on activities that were related to course whereas the rest of time (30.36%) on activities not related to course.

In the next part of the survey, participants remarked on a 5-point scale (Strongly agree [5]; Agree [4]; Neutral [3]; Disagree [2]; Strongly disagree [1]) how much they agreed upon a list of statements concerning advantages and disadvantages of letting students use their own computers in classroom (Table 5).

**Table 5: Mean perceived advantages and disadvantages caused by activities non-related to course**

<table>
<thead>
<tr>
<th>Advantages/disadvantages</th>
<th>Strongly disagree [1]-Strongly agree [5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved my motivation to learn</td>
<td>4.07</td>
</tr>
<tr>
<td>Enhanced meaningful course-related interactions in class through online communications</td>
<td>4.27</td>
</tr>
<tr>
<td>Enabled me to actively explore information for learning as I look for online resources</td>
<td>4.13</td>
</tr>
<tr>
<td>Distracted my attention from teacher’s teaching</td>
<td>3.80</td>
</tr>
<tr>
<td>Enabled me to become more attentive in class</td>
<td>2.93</td>
</tr>
<tr>
<td>Made me appreciate that the teacher was considerate to students’ needs</td>
<td>3.73</td>
</tr>
<tr>
<td>Made me more willing to attend class</td>
<td>4.13</td>
</tr>
</tbody>
</table>

On the one hand, students were very positive about the benefits of having their computers handy in the classroom. They agreed with advantages such as 1) Improving their motivation to learn (4.07); 2) Enhancing meaningful course-related interactions in class through online communications (4.27); 3) Enabling them to actively explore information for learning as they looked for online resources (4.13); 4) Making them appreciate the teacher was considerate to students’ needs (3.73), and 5) Making them more willing to attend class (4.13).

On the other hand, however, students also recognized the potential danger that computers can be a source of distraction. They agreed such practice would distract their attention and stopped them from listening to their teachers (3.80). Also, they did not tend to agree that notebooks “Enabled me to become more attentive in class” (2.93). Thus on the whole the findings clearly showed a very mixed sentiment held by students concerning the use of personal computers in the classroom.

In the last part of the survey, participants were asked to comment on whether computer use in class could be integrated into other academic contexts, ranging from other courses at the university to classrooms in secondary schools. Table 6 summarizes their responses.
Table 6: Mean perceived possibility of transfer of notebook use in classroom

<table>
<thead>
<tr>
<th>Possibility of transfer</th>
<th>Strongly disagree [1]- Strongly agree [5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>I would like to be allowed to use personal computers in my other courses,</td>
<td>3.73</td>
</tr>
<tr>
<td>I will learn better if I can use personal computers in my other courses.</td>
<td>3.40</td>
</tr>
<tr>
<td>I think secondary school students can benefit if they are permitted to use computers in classroom.</td>
<td>2.33</td>
</tr>
<tr>
<td>When I am teaching, my students should be allowed to use personal computers in the classroom for better learning outcomes.</td>
<td>2.20</td>
</tr>
<tr>
<td>Under the present situation, I think it is practical to promote computer-in-classroom in schools.</td>
<td>2.73</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>2.88</strong></td>
</tr>
</tbody>
</table>

In the university context, some of the students remarked that such practice could be made available to other courses (3.73) and they believed they would learn better if they adopt such practice (3.40). In the open-ended remarks, these students explained that being able to use computers in class provided them greater degree of autonomy. They were able to access to a wide range of online resources and references instantly, including powerpoint slides for their lectures and readings that were reading to their course. Moreover, by allowing access to the internet, they were able to share files with each other via the course platform. The combined effect enhanced the learning experience among students.

Some of the students, however, regarded technology a likely distraction in other university courses. In particular, many courses do not seem to relate to online resources or they are not benefited by additional online interactions in class (perhaps because there are already discussion opportunities).

As for the transferability of the practice to classes in secondary schools, students’ comments were very conservative. They disagreed with the idea that secondary school students would benefit if they are allowed to use notebooks in classroom (2.33). They disagreed that students should be allowed to use notebook in class even at the expense of achieving better learning outcomes (2.20). Moreover, they doubted it was practical to promote notebook use in classroom to schools in Hong Kong (2.73). According to them, secondary students were not mature enough to exercise discipline. Rather than taking notes with their notebooks, they were more likely to engage in non-academic activities, which undoubtedly would distract their attention from teachers’ teaching.

Allowing computers in class can be distracting from the teacher’s point of view too. The teacher found that students did not look at him during class as they were all reading materials on their own notebook screen. Students smiled at times during a demonstration when it was supposed to be a serious one - he suspected his students were engaged in non-academic activities. Also, some of the students typed actively and nosily throughout the whole lecture, and this was annoying to the teacher as well as the other students.

The teacher, however, also recalled times when notebooks in class led to apparent teaching and learning benefits especially in the guided usage. For example, he observed that students engaged in class activities more actively when these activities involved the use of web materials. Besides, by allowing notebooks in class, he was able to explain content more clearly particularly when the class was about software, platforms and web pages students can get access to exactly at the time the teacher was talking about them. It was especially useful when he had to demonstrate operation of software in class. Some of these demonstrations normally took some time to set up and students often had to wait for long. Rather than waiting, the teacher was able to instruct his students to follow the steps required to set up these demonstrations.

Concerning free use, teachers also felt more comfortable suggesting additional reading materials and learning resources to students. He also found that some students asked more in-depth questions in class perhaps because they had been doing additional reading in class.
3.2 Study two

Participants in the second study were asked three open-ended questions concerning whether they would support the use of digital devices by students in the local secondary schools in three different scenarios. Two of the scenarios were the comparatively guided use of the devices for teaching and learning: for classroom interaction (e.g. uReply), and for replacing paper-books with e-textbooks. The third scenario was free use and teachers just give free hand to students to do what they like with their own devices while they are teaching.

The participants were less comfortable with the free use scenario. Only three out of the 14 remarks collected in this question indicated a clear ‘yes’ and claimed they would let students use their digital devices on their own free will when they teach in the future. As expected, distraction was the main problem related to free use. Below are some remarks related to this concern. The “+” symbol indicates that the statement was a translation from Chinese; the “*” mark indicates that the statement has been subjected to considerable editing for language reasons.

- “No, classroom management will be a huge problem. Teachers cannot monitor each student all the time. Students are easily distracted by mobile devices.”
- “I don’t agree because e-devices may distract students’ attention in class.”
- “No, because they will not concentrate on their study.”

Comparatively, the participants were more positive if the digital devices would be used for more specific learning purposes. 14 out of the 16 remarks collected, for example, were supportive of the use of student response systems such as uReply in classrooms. They acknowledged advantages such as increased interactions as well as learning motivation.

- “It gives more chances to students to voice out and to participate in extended discussions”
- “Yes, because it can improve students’ motivation.”

However, the participants were much more conservative with the use of e-textbooks. Only five out of the 16 comments received were clear-cut “yes” to the question. Another two were lukewarm or they remarked that e-textbooks are good in only some specific teaching and learning contexts.

The participants were able to identify many more potential challenges if the guided use of digital devices in the classroom is long-term rather than occasional. For example, equity will be an issue.

- “I just worry about the expenses, especially for some poor students.”
- Usability becomes much more important if it is a long-term strategy.

- “Long term use is strainful to the eyes.”
- “Students can drop notes more easily on paper.”

There are also administrative and practical problems.

- “I am afraid that the secondary schools may not allow students to bring their phones into the classroom.”
- “Using e-textbooks needs school to have supporting infrastructure which cost problems and difficulties to many schools.”

Lastly and interestingly, the same distraction problem surfaces. Apparently, teachers are not confident that they can really control and monitor each and every student’s activities on their digital devices.

- “So the classroom management is also important.”
- “It is because they can write on paper-books and they pay more attention to the teaching.”

The line between guided and free use thus cannot be clear-cut when the digital devices become standard equipment in a classroom. The results showed once again the complexity of the issue at hand.

4. Discussion

The results in general confirmed that the use of digital devices in classroom is a controversial and complicated issue. On the one hand, it impacts positively on learning. Participants in current study believed that computer uses related to course were beneficial to their learning. Participants in current study remarked that they spent the majority of their time (70%) on course-related tasks on the
computers. They reported activities that were course-related to be beneficial to their learning substantially. Out of the 70% of participation in academic-related activities, participants read class materials most frequently and perceived academic-related activities to be beneficial to their learning experience.

On the positive side, our findings affirmed some of the optimistic views in the literature. For example, Mackinnon and Vibert (2002) regarded notebook use in classroom to be effective in enhancing motivation, the ability to apply course based knowledge, and overall academic achievement among students. The adoption of notebook in local classroom in the present study also produced a prominent effect in motivation. Participants in our study agreed that by allowing the use of digital devices in classroom, they were more motivated to learn in class. Thus, unlike Tesch, Coelho and Drozdenko (2011) and Hembrooke and Gay (2003) who tended to have a more pessimistic view towards the issue and regard notebook activities in the classroom distracting, results of this study suggested that the practice becomes a problem only when users engaged in non-related activities whereas such practice served as a facilitator to learning if activities engaged were course-related.

We found to a certain extent an enhanced motivation to learn as well. The findings corresponded with past results uncovered by Fitch (2004) and Stephens (2005) where notebook use in their research revealed enhancement in in-class participation and engagement. Our finding was consistent with Barak et al (2006) too, as notebooks installed with wi-fi seemed to increase active exploratory learning. Also, notebook use in class seemed to have encouraged students to attend class. Increase in participation rates was also found in past research by Trimmel and Backmann (2004). They found that students who were in computer-possible classrooms, in comparison with those who weren’t, had higher participation rates, enhancement in interests and motivation to perform well during the course.

On the other hand, the disadvantage is also real that there is the temptation to use the computers for irrelevant purposes in class. Our studies thus showed people were conservative about channeling the use of computers in classroom to other academic contexts, especially in secondary school setting with the less mature students.

The problem of potential distraction is obviously more serious in the free use scenario. However, we found distraction can also be a problem in the guided use situation too when the digital device becomes a long-term standard equipment in the classroom. Teachers just cannot monitor every minute of the class. It seems that the most comfortable scenario now for most teachers now is an occasional use of digital devices for guided activities in the classroom.

5. Conclusion

The present study revealed that use of digital devices was effective in enhancing motivation, the conduct of meaningful course-related interactions, active exploration of online information, and participation rates. Nevertheless, even for those who acknowledged the benefits of use of digital devices in class, some of them reported to have been distracted at times during the lecture. In fact, the teacher who was responsible for the course in the first study had also experienced occasional distress in maintaining attention among a number of students.

Apparently, the answer to the question whether computers be allowed in class should not be a simple yes or no but is a series of suggestions concerning when and how. Therefore, in order to address these negative impacts, it is necessary to provide guidance and instruction for students to refer to if notebooks are to be used for achievement of better learning outcomes.

As an implication, therefore, the real challenge is on promoting good practices. In this regard, we identified a few factors relating to these good practices. First of all, students’ characteristics seem to be an important factor as most of the time we rely on students’ ability to control themselves to do things appropriately. Maturity of the students is also the main reason why many of our students did not regard the practice a good idea in secondary school classrooms.

Second, meaningful activities are important. For example, in the course of the first study, the computers assisted students’ understanding of course-related software and the procedural knowledge needed in using software. The additional materials on the web were also important suggested readings of the course. Also, teachers had a package of teaching materials in digital format and students could easily retrieve them, view them and work on them on their computers during the class.
In the second study, the students appreciated that the use of digital devices actually led to richer interaction in class and thus enhanced learning outcomes.

Third, new teaching skills may be important too. Teachers need to design class learning activities that incorporate the use of technology. Teachers should also be more attentive to what students are doing on their computers. Interfere at times when s/he thinks computers are turning into distractions.

We would like to emphasize again the pilot-study nature of the present study. The study is seriously limited as we studied a very small cohort of students in one course over one semester. The preliminary findings and implications are of interest but they are yet to be subject to further investigation in future studies.

References


Tesch, F., Coelho, D. and Drozdenko, R. (2011) ‘The relative potency of classroom distracters on student concentration: We have met the enemy and he is us’, in Proceedings of American Society of Business and Behavioral Sciences 2011 (pp 886–894), ASBBS, Las Vegas, VA.


Learning Paramedic Science Skills From a First Person Point of View

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Abstract: Paramedic students need to acquire knowledge and skills necessary to perform basic as well as complex clinical skills, to ensure patient safety, and to manage sophisticated equipment. Time and resource pressures on students, teaching staff and institutions have led health professional educators to develop and embrace alternative opportunities such as simulation and multimedia in order to develop a student’s clinical expertise in preparation for clinical placement. Paramedic education laboratories are equipped with simulation equipment to facilitate the acquisition of the psychomotor skills required by paramedics, and are the main spaces where students can practice essential paramedic skills in a non-threatening environment. However, often the learning environment is encumbered by ‘noise’ or obstacles such as the educator’s body, or ambient noise from other students, staff or equipment, all which inhibit a clear and precise view of the intricate details of skills to be learned. This study addressed the crowded laboratory and ‘noise’ issues through the use of video learning resources. Though using video as a learning resource is not new, there are three facets to learning that make this project innovative and beneficial to the learner; one, learning from a video composed from a first person point of view (1st PPOV); two, the viewing of the video learning materials using a mobile device such as a smart phone; and three, the use of QR codes to access the online videos. Six 1st PPOV video vignettes were produced for this study. Each video was less than two minutes and length, clear and instructional on selected psychomotor clinical skills required for acute care provision. The research findings show that the 1st PPOV videos positively impacted students’ (n=87) learning of the six skills, and gave them a more comprehensive view and understanding of the skill in context. The findings also indicated that accessing the videos on a mobile phone was a bonus. The participants requested additional 1st PPOV skills to be included in the blended learning design across all areas of their Paramedic Science program.

Keywords: first person point of view, learning in the first person, paramedic science, paramedic science skills, skill acquisition, experiential learning, video learning materials

1. Introduction

Paramedics’ skills are life saving skills - however, it is often difficult to acquire these skills. Viewing and learning these skills using videos that are taken from a first person point of view, and viewing them when and where you need them, is important to all (Fukkink, Trienekens, & Kramer, 2010).

A groundbreaking report into paramedic education (Willis, Pointon, & O’Meara, 2009) identified three improvements to curriculum development and delivery. First, a critical need for low cost student-centred ways of teaching clinical skills. Second, a defined signature pedagogy in paramedic education. Third, inter-disciplinary education for paramedic students as paramedic graduates need to be competent in interdisciplinary team work and to function as first line public health/health promotion responders in pandemic situations (Tippett et al., 2008). All of these issues were addressed during the project reported in this paper.

While the literature posits that clinical skills training is critical and that video training is a promising area (Pea, 2006; Fukkink, et al., 2010; van Det et al., 2011; Xiao et al., 2007), there is a lack of information regarding the blending and use of simulation and videos from a first person point of view. Thus the aim of the study was to evaluate the perceived effectiveness of videos recorded from a first person point of view for paramedic clinical skills development. The study has two phases; the development of prototype video vignettes using a first person point of view together with evidence to guide and support the development of further vignettes, and stage two, the development of an extensive set of video vignettes together with an evaluation of their use in the simulated classroom or in situ. It is the initial findings from stage one that are reported in this paper.

2. Background

Paramedic students need to acquire knowledge and skills necessary to perform basic and complex paramedic skills, assure patient safety, and manage sophisticated equipment (for example, Deakin, issn 1479-4403 396 ©Academic Publishing International Ltd Reference this paper as Lynch K, Barr N and Oprescu F “Learning Paramedic Science Skills From a First Person Point of View” The Electronic Journal of e-Learning Volume 10 Issue 4, 2012, (pp396-406), available online at www.ejel.org
Demands for accountability, increased patient acuity levels, scarce quality clinical placements, and increased enrolments in professional programs have led health professionals to embrace alternative opportunities such as simulation and multimedia artefacts to develop a student’s clinical expertise. A wide range of teaching materials are available for students in health sciences, including paramedic science. However, most of them are in traditional formats such as textbooks and tutorial workbooks (which are only partially engaging by their nature). An analysis of the literature indicates that the use of video is seen as having the potential to transform learning, in health sciences (Kim et al., 2010; Williams et al., 2010).

Paramedic education laboratories improve authenticity of the learning design, which reinforces clinical concepts and supports clinical practice in a safe and non-threatening environment (Boyle, Williams, & Burgess, 2007). These laboratories are equipped with simulation equipment that “can enhance learning and provides a stimulating environment” (Starkweather & Kardong-Edgren, 2008, p. 1), facilitate the acquisition of the psychomotor skills required by paramedics, and allows a place where they can practice these skills in a non-threatening environment. In paramedic training, simulation and videos have been used in relationship to training for example, general clinical skills, drug administration, continuing education, and disaster management.

Furthermore, with opportunities for just-in-time learning that have been brought about by technological advances such as the ‘smart’ mobile phone, learning and re-learning at the bedside of a patient is a common approach taken in nursing education (Waldner & Olson, 2007). The 2012 Horizon Report identifies that mobile devices (smart phones and tablets) are expected to enter the mainstream of higher education within the year (or less) (NMC Horizon Report, 2012). Mobile learning opportunities could help students arrive in the clinical setting better prepared and with greater confidence (Jeffries, 2005). However, often the learning environment is encumbered by obstacles such as the educator’s body, ambient noise from other students, staff or equipment, all which inhibit a clear and precise view of the intricate skill to be learned. Reviewing a video presented on a mobile phone of a skill composed in the first person could overcome these obstacles.

3. Research questions

The literature review, academic need and industry insight underpinned the following research questions:

- To what extent do short videos of intricate paramedic clinical skills filmed from a first person view are perceived to enhance learning?
- What value to the learner is the ability to view a first person learning object on a mobile device?

4. Research design

This project was conducted following a design-based research methodology using mixed data collection and analysis methods. This methodology was selected as it “improve[s] educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings” (Wang & Hannafin, 2005 p.6).

Design-based research usually entails a continuous cycle of design, enactment, analysis, and redesign (Collins, 1992). This approach was deemed suitable for the project as its iterative nature would determine what learning objects were required according to the study participants and the literature, refining the learning objects themselves, and evaluation of their use. The interpretative approach used to explore the data collected enabled the researchers to “learn what is meaningful or relevant to the people being studied” (Neuman, 2000 p71).

Research projects that adopt the design-based methodology typically involve both the design of certain forms of educational interventions based on a particular theoretical framework and systematically studying these forms in context, in order to better understand the various issues that target domain specific learning processes (Cobb, et al, 2003). The intervention used in this study was presenting students with short videos of an expert performing basic paramedic clinical skills filmed from a first person point of view. The theoretical framework underpinning the study is that of experiential learning.
4.1 Experiential learning

Chee (2001) argues that learning needs to be embedded or ‘rooted’ in experience (p43); or ‘experiential learning’. Experiential learning is well recognised by educators as a rewarding student-centred learning approach. Virtual reality, simulations and merged or concoctions of both, together with advances in information and communication technologies, have opened up numerous technology rich avenues for experiential learning. However, as argued by Roschelle (2003), Herrington and Kervin (2007) and others, technology needs to be underpinned by “theoretically [pedagogically] sound ways” (Herrington & Kervin 2007 p219). Technology on its own does not make for a good and valuable learning experience for the learner. Pedagogy and curriculum play crucial roles in education, and need to be seriously considered when developing a technology-rich experiential learning experience.

A number of adult learning principles from theories by such thinkers as Malcolm Knowles (1950) and Carl Rogers (1961), were used to inform the design and deployment of the project.

4.1.1 First person point of view

First person point of view (1st PPOV) is commonly used in computer games to engage the ‘player’ to participate first hand in the action of what is happening. It is commonly used in ‘shoot them up’ and adventure games. Objects created using this point of view can show a realistic perspective as the learner sees what they would see if they were actually doing the action themselves, with the resultant experience becoming either authentic or experiential. The study presented here implements 1st PPOV in learning objects where the user engages in direct interaction with the elements of a simulated environment; the environment in this study being a simulated paramedic skills experience.

Simulated learning experiences can provide students in a given cohort with opportunities to develop specific clinical skills, as well as supporting clinical decision making and the development of critical thinking skills in a safe and controlled environment. As more sophisticated resources for simulation-based learning become available, students will have opportunities to learn through multi-sensory patient care scenarios requiring demonstration of cognitive, psychosocial and psychomotor skills. These opportunities will help students arrive in the clinical setting better prepared and with greater confidence (Jeffries, 2005).

4.1.2 Time and place for learning

Wireless mobile learning devices have the potential to achieve large-scale impact on learning because of their portability, low cost, and variety in communication features (Rochelle 2003). The argument is how to make the best educationally sound use of mobile devices? Modern telecommunication systems, in particular, mobile telecommunication, can aid in delivering this content to the learner in situ. In the paramedic laboratory/lecture setting (as well as in other skills training situations), it could be beneficial to view skill training artefacts at a time and place paramedics require further instruction or a refresher. This concept is supported in general by researchers such as Rochelle 2003; Lehner, F., Nösekabel, H., and Lehmann (2003); and Liang et al., 2005; and in the health arena in particular by Fisher, et al. 2006; Lai, et al. 2007; and Lynch, et al. 2010.

The nature of mobile devices encourages their use in personal spaces, such as in the case of our proposed project, clinical practice or personal revision of a skill, and as such they can be used for reinforcement by an individual, or if the device is ‘passed around’ cooperative learning can take place. Lai et al (2007) claim that “mobile technologies are effective in improving knowledge creation during experiential learning” (p326); experiential learning is the learning principle of choice in western education today. The use of mobile devices in education can “assist active knowledge acquisition by the learner” (Lehner, Nösekabel & Lehmann 2003 p25) and “they provide ’just enough, just for me, just in time’ learning” (Taylor et al., 2011, p180).

Studies on the use of mobile devices in the nursing setting have been undertaken, where they have been found to be an effective resource for students, especially for reference materials(Miller et al., 2005). Other studies demonstrated that the benefits of m-learning for student nurses were improved lecturer and peer support, better access to information and resources, and the ability to record and reflect on their clinical experiences in real time (Dearnley & Matthew, 2007; Taylor, Coates, Eastburn, & Ellis, 2006).
Given the perceived value of mobile communications for learning, it was decided to develop the projects learning objects in formats that could be viewed on a mobile device such as a ‘smartphone’ or tablet computer.

4.2 Developing the 1st PPOV videos

Analysis of the case institution’s paramedic curriculum and local practice were undertaken to identify an initial list of skills that are critical to the skills development of student paramedics. Additionally, an exploration for external resources was conducted so as to not to duplicate what already existed, and to identify existing resources that were of poor quality or inappropriate.

The skills selected were:
- Check an airway
- Triple airway manoeuvrer
- Nasopharyngeal insertion
- OP Airway insertion
- Ventilation BVM
- Yankaeur suction

Script outlines were formulated for each skill, taking into consideration that an ad hoc, first person think aloud style was the best approach (Lynch et al 2010). The scripts were reviewed by peers for accuracy and thoroughness.

Filming the videos was undertaken in a simulation laboratory using real paramedics and human patients or mannequins. A mannequin was only used when the skill involved an invasive procedure, as previous research conducted by Lynch et al (2010) showed that using a human rather than a mannequin made the experience more authentic to the learner. The video equipment used was a head mounted camera with inbuilt audio.

Once the videos were peer reviewed for accuracy and thoroughness, they were clipped to delete unnecessary frames, branded, and saved in mp4 format.

Dissemination of the videos was through the University’s learning management system and YouTube (see Figure 1). The YouTube urls were displayed as QR codes in the paramedic laboratory.

Figure 1: YouTube
4.3 Methods and procedures

A mixed methods research approach was used for collecting and analysing data. An online survey was developed and accessed via the learning management system; there were 87 usable responses (an overall response rate of 66%). The study was conducted at an Australian tertiary education institution in a paramedic course that includes both first year (52% response rate) and second year (83% response rate) students.

4.3.1 The survey

The survey contained quantitative questions to collect data so as to create a profile of the respondents; including questions such as the number of semesters completed, study mode, and device ownership. The survey also asked where (from a given list) did they accessed the videos. There were 11 Likert scale questions relating to students’ perceptions as to learning the skills from the videos; their preferences for video length, content and place of access. The survey allowed for open ended comments, as well as specific questions requiring a textual response such as suggestions for improvement, perceived impact on learning, and perceived barriers and facilitators to learning using videos from a 1st PPOV.

4.3.2 Analysis

The quantitative data was analysed using the assistance of SPSS (Statistical Package for the Social Sciences) allowing for preliminary findings to be drawn from the data that then could be used as a basis for a more extensive study. Qualitative data used a thematic approach, and coded the responses according to derived themes.

5. Results

The respondents were evenly spread between first and second year students studying paramedic science primarily studying full-time at the case Australian university. Over half of the respondents owned a smartphone (see Table 1).

Table 1: Profile of respondents

<table>
<thead>
<tr>
<th>Question</th>
<th>n=87</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two semesters studied</td>
<td>44</td>
<td>50.6%</td>
</tr>
<tr>
<td>Three or more semesters studied</td>
<td>43</td>
<td>49.4%</td>
</tr>
<tr>
<td>Full time status</td>
<td>85</td>
<td>97.7%</td>
</tr>
<tr>
<td>Own a smartphone owned</td>
<td>56</td>
<td>64.4%</td>
</tr>
<tr>
<td>Own a tablet PC</td>
<td>16</td>
<td>18.4%</td>
</tr>
</tbody>
</table>

n= number of valid responses

The participants were asked from where they actually access the videos. The results are presented according to the year level of the students in Figure 2 and Error! Reference source not found.). It was found that they accessed the videos mostly from their home computer, followed by the university paramedic laboratory, a mobile phone, then through the use of the QR code.

Figure 2: 1st year students actual access to the first-person clinical skill videos
Further, data was collected on the most likely ways they access the videos (rather than how ways in which they actually accessed them – as presented above). Students were asked to rank the location of access from the most likely (1) to the least likely (8). Answers were aggregated into a relative score using the following scoring system: a first preference is worth 1.0, a second preference worth 0.875, a third preference is worth 0.750 etc, decreasing in intervals of 0.125. Preference point totals for each medium were multiplied by their respective fractional value, and then added to produce a total score. Therefore, a selection that contains predominantly second preferences could still achieve a higher score overall than a selection containing many 1st and 8th preferences. In this way, every vote counts to produce a more accurate overall representation of everyone’s preference. (see Error! Reference source not found.).

Table 2:

<table>
<thead>
<tr>
<th>Q 18 – Where would you most likely access the videos?</th>
<th>Mobile</th>
<th>Mob Lab</th>
<th>P Lab PC</th>
<th>Lab PC</th>
<th>PD LT</th>
<th>P Home</th>
<th>Mob Case</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st year</td>
<td>4th</td>
<td>6th</td>
<td>3rd</td>
<td>2nd</td>
<td>5th</td>
<td>1st</td>
<td>7th</td>
<td>8th</td>
</tr>
<tr>
<td>Relative Score</td>
<td>45.9</td>
<td>36.4</td>
<td>51.8</td>
<td>52.0</td>
<td>41.7</td>
<td>76.2</td>
<td>29.1</td>
<td>10.5</td>
</tr>
<tr>
<td>2nd year</td>
<td>3rd</td>
<td>4th</td>
<td>2nd</td>
<td>5th</td>
<td>6th</td>
<td>1ST</td>
<td>7th</td>
<td>8th</td>
</tr>
<tr>
<td>Relative Score</td>
<td>50.2</td>
<td>49.7</td>
<td>58.1</td>
<td>44.6</td>
<td>37.9</td>
<td>67.6</td>
<td>24.8</td>
<td>6.4</td>
</tr>
<tr>
<td>Year 1 &amp; 2 combined ranking</td>
<td>4 th</td>
<td>5 th</td>
<td>2nd</td>
<td>3rd</td>
<td>6th</td>
<td>1st</td>
<td>7th</td>
<td>8th</td>
</tr>
<tr>
<td>Relative Score</td>
<td>48</td>
<td>42.9</td>
<td>54.9</td>
<td>48.4</td>
<td>39.9</td>
<td>72</td>
<td>27</td>
<td>8.5</td>
</tr>
</tbody>
</table>

The format of the videos is an important access and equity related feature. The students were asked to select the most likely format of accessing the videos. The options were; an external video hosting service where the transfer load is debited from student’s data download use account, for example YouTube; streamed through the university’s infrastructure thus being debited from a student’s Internet use allocation if one campus, or other if off campus; or as a downloadable file so that the file can be re-viewed without further Internet use charges (see Figure 4; the figures used are percentages of participant responses, and is categories according to year of study).

Further, the survey asked the respondents to indicate their level of agreement (1= Strongly disagree; 5 – Strongly agree) to eleven statements in an endeavour to elicit their perceptions as to the value of the videos for learning (see Table 3). The aggregated data are found in Figure 5.

Open ended questions asked for comments regarding the students’ perceptions the impact the 1st PPOV videos would have on the acquisition of the skills. The overwhelming response was related to the PVO videos improving the learning of skills by the student. The use of the videos for revision, and the request to have them available earlier on in the degree (and more of them) were the next most common comments. Figure 6 presents these themes as a word mashup; the larger the font the greater the number of occurrences of the comment or theme.
**Table 3**: Questions relating to the students’ perceptions of the value of the videos to their learning

<table>
<thead>
<tr>
<th>Q5. The 1st PPOV videos could be very beneficial for student learning</th>
<th>Q11. Using the 1st PPOV videos for learning relevant clinical skills will take up too much of my time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q7. The 1st PPOV videos would be of greatest benefit to students if they were used at the very beginning of a paramedic course</td>
<td>Q12. Using the 1st PPOV videos is more efficient use of my time than traditional learning materials (i.e. textbooks)</td>
</tr>
<tr>
<td>Q8. The 1st PPOV videos would be of greatest benefit to students if they were used throughout the entire paramedic program</td>
<td>Q13. Using the 1st PPOV videos for learning paramedic clinical skills will increase my confidence in my ability to perform these skills</td>
</tr>
<tr>
<td>Q9. The 1st PPOV videos would be of greatest benefit to students if they were used in the learning of paramedic clinical skills</td>
<td>Q14. Using the 1st PPOV videos on how to complete an ERF would be valuable for my learning</td>
</tr>
<tr>
<td>Q10. Using the 1st PPOV videos will help me learn clinical skills faster</td>
<td>Q15. A 1st PPOV video that displays a systematic approach in the paramedic practice model would have a positive impact on student learning</td>
</tr>
<tr>
<td>Q16. Using a 1st PPOV video showing the inside of an ambulance and the location of equipment would be valuable for my learning</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4**: Format and access preferences

**Figure 5**: Aggregated responses relating to the students’ perceptions of the value of the videos to their learning
The videos were placed onto YouTube so that they could be accessed outside the Course web site thus not requiring a long in, and thus making them freely available to anyone (who found them). It is interesting to discover through the data logs available in You Tube, that links to the videos where being directed from not only the University web site, but also from Twitter, Facebook and Google; and access from countries other than Australia.

Over a five month period our most popular YouTube clip was the triple airway manoeuvre, followed by check airways, table / presents the number of total views and is ordered in most to least popular.

<table>
<thead>
<tr>
<th>Order of popularity</th>
<th>Skill</th>
<th>No. of Views</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Triple airway (full) manoeuvre</td>
<td>443</td>
</tr>
<tr>
<td>2</td>
<td>Check airway</td>
<td>415</td>
</tr>
<tr>
<td>3</td>
<td>Ventilation BVM</td>
<td>359</td>
</tr>
<tr>
<td>4</td>
<td>OP Airway insertion</td>
<td>353</td>
</tr>
<tr>
<td>5</td>
<td>Nasopharyngeal insertion</td>
<td>340</td>
</tr>
<tr>
<td>6</td>
<td>Yankaeur suction</td>
<td>338</td>
</tr>
</tbody>
</table>

The Triple airway (full) manoeuvre video was the fifth in the YouTube playlist, indicating that is position in the list was not its reason for its popularity. The video shows how the complete procedure is undertaken, which is what the students wanted to see; a flowing un-segmented sequence. The students indicated that they preferred the skills to be performed on a person rather than a mannequin; the triple airway manoeuvre was undertaken on a mannequin due to the intrusive nature of the full procedure, however, the students recognised this as unavoidable.

6. Discussion

With technology continuing to influence the delivery of education, and universities being required to develop more effective and flexible delivery strategies, web-enhanced blended learning environments are becoming universal. It is clear that teaching and learning approaches have moved away from simply transmitting information from lecturer/book to the learner, to more diverse approaches of teaching. The use of video learning materials to assist in learning skills has been used for many years, and there is no question, that in general, they can be a valuable learning and training resource. The project presented here moved two steps further in this use of video material for learning in that
the video material was produced from a first person point of view and made available in a format suitable for viewing using a mobile device.

The study addressed two research questions, the first relating to the use of first person videos to enhance learning; the second, the perceived value of the first person videos on a mobile device. These questions were answered through the collection of survey data obtained voluntarily and anonymously from the first/second year cohort of paramedical science students at an Australian university (66% response rate).

A limitation of the study was the relative small sample size and the regional nature of the case university; however it is felt that a substantially larger sample size from a broader range of dispersed universities may not detect any additional insight.

6.1 Enhance learning

The research findings indicate the students’ perceptions that the 1st PPOV videos will have a positive impact on their learning of the six skills under study, and provide them with a more comprehensive view and understanding of the skill in context as a student summarised it below:

“Because I can read a textbook and go ‘oh yeah’ and then have absolutely no idea what I’m doing, but if you see it done, you’re shown it and then you do it, and then if you do something wrong you can go back and look at it and see exactly where you went wrong… or where you went right.”

Students requested additional skills to be included in the 1st PPOV learning design across all areas of their Paramedic Science program, requesting more 1st PPOV videos to be made available to them – and from the start of their learning of clinical skills. This adds additional support to the existing literature around use of video in health education (Kim, et al., 2010; Williams, et al., 2010; Cardoso et al., 2011) and encourages innovations using blended learning (Ruiz, Mintzer, & Leipzig, 2006; Williams, 2009). One of the unforeseen findings was the students’ recognition that these skills, though they may become mechanical after some time, the skill performer continually goes through a deep cognitive process – each of which are specific to the situation at hand, every time they perform the skill. This insight into the psyche of the expert was deemed to be invaluable to their learning.

One important finding was that the duration of the videos needs to be as long as necessary but as short as possible. The videos under study were all planned to be less than 60 seconds – however some skills took a little longer due to their complex nature, no video was longer than two minutes in order to minimise the cost on students’ time and Internet download charges, and to allow for fast review of the video if required. Future research could look at the best content coverage/time balance from the perspective of the students. In terms of content, the study only focused on the correct performance of the skills. Future developments may include suboptimal treatment as well in order to allow for critical discussion during practical sessions or during assessment.

1st PPOV video recordings could be used for multiple purposes: training, assessment, self-assessment, practice, skills review and more. A number of the student responses indicted that it would be valuable if skill ‘tip sheets’ were developed alongside each video to accommodate for those learners also like to read or would rather read instruction than view them. This multiple format is in line with good pedagogical practices.

Video production needs to be setup in a way that balances professional quality of the video with realism (one of the participant’s commented was that a steadier footage would be desirable). It is important to note that video editing capabilities are desirable and that appropriate resources need to be dedicated to pre and post video production. The decreasing costs of video equipment and video editing suites make such endeavours more and more cost-effective.

A structured approach to the planning, implementation and evaluation has been used. Through team reflection the following success factors for the project have been identified: an analysis of the teaching and learning needs; defined objectives; attention to learning materials, resources and capacity required for successful production of learning materials; and a research project of sufficient size to allow for systematic evaluation.
6.2 Viewing on a mobile device

Over half (64.4%) of the survey respondents indicated that they had a ‘smart’ mobile phone, with a further 18.4% indicating a ‘tablet’ computer; each of these devices are capable of displaying the videos produced on a mobile-internet enabled device. However, the access penetration of a mobile device was relatively insignificant (around 10%) even though the comment was made by many participants that accessing the videos in such a way was useful.

This mismatch could be due to the students not having the knowledge of how to access the content using a mobile phone. It needs to be noted, the urls for the videos were available as QR codes, however very few students knew how to read and execute the QR code on their phone. Further, the complex nature of YouTube urls, are probable factors in the lack of actual access on a mobile device, however, the participants made comment as to the benefits of doing so. Regardless, accessing the videos using a mobile phone was ranked fourth (out of 8) overall.

7. Conclusion

Six short videos of paramedic clinical skills were developed by an interdisciplinary team and evaluated in terms of learning with positive results by a student cohort. The use of first person point of view videos was perceived by students to enhance their learning of clinical skills as viewing how to do these skills through the eyes of an expert was authentic and immersive. Furthermore, having videos of these skills that were accessible anywhere at any time was seen as a very valuable learning resource.

In an endeavour to guide further development and research, an evaluation of the 1st PPOV video learning materials included assessment of outcomes such as usability of content, learner satisfaction and learner input.

The findings suggest that learning videos filmed from a first person point of view, using people (and mannequins only where appropriate), stepped as well as a completed sequence, and available as a downloadable file as well as streamed, will engage the learner, improve skills understanding and acquisition, be valuable for revision and retention, and enhance learning. Accessing these videos using a mobile device was seen as beneficial; however, this aspect needs to be investigated further.

It is evident that additional investment and research in the learning of paramedic clinical skills using first person point of view video learning materials needs to continue. As such the research team is developing more video materials from a 1st PPOV – the skills of which are drawn from the suggestions in the survey responses, as well as introducing the materials into the curriculum from the beginning of the paramedic science program.

Acknowledgements

This project was supported by a small learning and teaching grant from the University of the Sunshine Coast, Australia. The research team would like to take this opportunity to acknowledge the contribution of Damon Grimwood who was the research assistant on this project.

References


‘As a student, I do think that the learning effectiveness of electronic portfolios depends, to quite a large extent, on the attitude of students!’

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janem@hku.hk

Abstract: Lynch and Purnawarman (2004:50) point out that ‘a solid electronic portfolio can show reflection, evolution of thought and overall professional development’. Research shows that electronic portfolio assessment, if implemented thoughtfully, can successfully engage learners in critical thinking and problem solving, promote lifelong education, encourage self evaluation and allow learners to have a higher degree of control over the learning process (Pierson and Kumari, 2000; Mason, Pegler, and Weller, 2004). Given the value of electronic portfolios, there has been growing interest in using electronic portfolio assessment to support teacher education (Lynch and Purnawarman, 2004). In this paper, we discuss on-going efforts at the University of Hong Kong to design assessment tasks for a language awareness course entitled ‘Pedagogical Content Knowledge’. The final-year student teachers taking the course are required to compile an electronic portfolio based on their reflections on the relevance and applicability of the issues relating to dealing with the content of learning in pedagogical practice discussed in the course. This paper sets out to describe and analyze issues relating to the design and implementation of the assessment, focusing specifically on the challenges that the research team faces. In our paper, we draw on a range of data, including student teachers’ feedback on the assessment and in-depth reflections of two student teachers after the assessment to critically evaluate the extent to which the assessment has achieved the intended learning outcomes. The reflective study shows that apart from technical support, methodological and psychological preparation designed to help students to take on a more active role in the learning and assessment process are also needed to help students to perform effectively in the computer-supported assessment. Implications are drawn for those who plan to conduct electronic portfolio assessment in higher education.

Keywords: electronic portfolio assessment, psychological preparation, methodological preparation, assessment innovation, teacher education

1. Introduction

Given the value of electronic portfolios, for example, engaging learners in critical thinking and problem solving, encouraging self evaluation and allowing learners to have a higher degree of control over the learning process (Pierson and Kumari, 2000; Mason, Pegler, and Weller, 2004), there has been growing interest in using electronic portfolio assessment to support teacher education (Lynch and Purnawarman, 2004). In this paper, the research/teaching team discusses reflectively on-going efforts at the University of Hong Kong to design assessment tasks for a teacher language awareness course. The student teachers of L2 English taking the course are required to develop electronic portfolios based on their reflections on the applicability of the issues relating to dealing with different language systems in pedagogical practice discussed in the course. The paper sets out to describe the significance of portfolio and electronic portfolio assessment in education, and the implementation process of electronic portfolio assessment in the course over the last few years. A range of data, including the patterns that emerged in the electronic portfolios collected, student teachers’ feedback on the assessment and the in-depth reflections of the tutors and two individual student-teachers after the assessment, are drawn on to critically evaluate the extent to which the assessment has achieved its intended learning outcomes. Implications are drawn for those who plan to conduct electronic portfolio assessment in higher education.

2. Literature review

Portfolios, as defined in this study, are ‘rich, contextual, highly personalized documentaries of one’s learning journey. They contain purposefully organized documentation that clearly demonstrates specific knowledge, skills, dispositions and accomplishments achieved over time. Portfolios represent connections made between actions and beliefs, thinking and doing, and evidence and criteria. They are a medium for reflection through which the builder constructs meaning, makes the learning process transparent and learning visible, crystallizes insights, and anticipates future direction’ (Jones and Shelton, 2011: 21-22). The portfolio building processes that learners go through engage them in a reflective inquiry process (Zubizarreta, 2004) and provide them with a holistic learning experience.
(Jones and Shelton, 2011), which helps to explain why different forms of portfolios and portfolio assessment have been widely adopted in the educational context worldwide (Kinnard, 2007). With enhanced features such as flexibility in storage, and production and dissemination (Barrett, 2000), the introduction of electronic portfolios has taken portfolio assessment in education to a new level.

The potential benefits of portfolio assessment have well been documented in the education literature. For example, the self-directing and on-going nature of the assessment, such as learners collecting and selecting items to be included in the portfolio, seeing connections between these artifacts and reflecting on them over a period of time (Mason, Pegler and Weller, 2004), encourage deep-learning (Moon, 2004), reflection (Stefani, Mason and Pegler, 2007), self evaluation and critical thinking (Pierson and Kumari, 2000), and develop in the learners a sense of voice (Jones and Shelton, 2011) and ownership of learning (Zubizarreta, 2004). All these benefits were the reasons why portfolio assessment was adopted when the language awareness course was first introduced in 2008. In order to prepare the student teachers of L2 English better for the literacy pedagogy challenge—the ‘burgeoning variety of text forms associated with information and technologies’ (The New London Group, 2000: 9)—the paper portfolio assessment was replaced by electronic portfolio assessment in the following academic year.

In addition to all the benefits of paper portfolio assessment mentioned above, electronic portfolio assessment offers learners a multimedia platform to design, produce and distribute their portfolios; for example, learners can enhance their portfolios using a combination of digital media including animation and sound effects (Kilbane and Milman, 2005). In fact, it allows learners greater flexibility in terms of capturing the items to be reflected on, storing the artifacts, and duplicating and distributing their portfolios (Barrett, 2000). According to Jones and Shelton (2011: 145), the ‘non-linear structure of electronic portfolios’ means that support documentation can be virtually attached where appropriate without compromising the overall community and flow of the document’. Specifically, in the context of teacher education, electronic portfolio assessment can engage student teachers in the use of technology so as to develop their digital literacy (Lane, 2009), as in this case study, in which one of the intended learning outcomes of the assessment was to develop student teachers’ understanding of the interplay between various types of knowledge including content, pedagogical and technological knowledge.

Despite their benefits, portfolio and electronic portfolio assessments present challenges to both implementers and builders. According to Parsons (1998), portfolio assessment needs to be approached with caution to ensure success. Also, Janesick (2011: 42) states that although teachers and students have been moving into the computer age ‘one can imagine that the transition to electronic portfolios is gradual and not necessarily easy’. In terms of the implementers, issues such as technical training for both staff and students, problems with portfolio archiving, and increased workload of faculty, all need to be dealt with properly. The issues of technology and time are two determining factors that need to be addressed in relation to both the implementer and the builder (Zubizarreta, 2004). In terms of teaching strategies, Biggs (1999: 2) points out the importance of ‘constructive alignment’, stressing that deep pedagogical approaches focusing on teaching for understanding, especially personal understanding (Lynch, McNamara and Seery 2012), are needed for deep learning assessment approaches such as electronic portfolio assessment.

According to Kinnard (2007), the process of constructing a portfolio is complex and consists of three major phrases: introspection, design and implementation. In the context of teacher education, the first stage involves student teachers reflecting introspectively on their teaching beliefs and practices with respect to the focus of the portfolio assessment. In the next two stages, the processes of collecting items to be included in the portfolio, selecting and categorizing them, and recording related reflections continue until the artifacts are actually arranged and presented in the portfolio. These processes, especially those involved in electronic portfolio building, could be novel to many student teachers and thus, methodological support is needed to help them commit to this time-consuming, and possibly daunting, portfolio building process. In terms of psychological support, Parsons (1998) stresses that learners need to be helped to see the active role they play in the ‘new’ learner-centred assessment, in particular, the importance of their engagement in this self-regulated (Nichols and Dawson, 2012) learning-and-assessment combined process (Hung, 2012).
3. Implementation of the assessment

3.1 The teacher language awareness course

The course into which electronic portfolio assessment was introduced is part of an initial teacher education programme that integrates English studies, education, English language teaching methodology and school experience. The course aims to develop the teacher language awareness of student teachers of L2 English as it relates to different language systems such as grammar, lexis and phonology. According to Thornbury (1997: x), teacher language awareness refers to the knowledge that teachers have of the ‘underlying systems of the language that enables them to teach the subject effectively’. In other words, language-aware EFL teachers, as in this case study, need to be able to reflect on their knowledge about language, and their knowledge of the learner, and draw appropriately on their knowledge about language in all aspects of their pedagogical practice (Andrews, 2007) to enhance language teaching and learning. An important principle underpinning the curriculum design of the course is the prioritisation of student teachers’ development of metacognitive awareness so as to help them assess their own knowledge about language, evaluate their own pedagogical decisions and performance, and modify their teaching assumptions and practices. The assessment task for the course aims to provide these student teachers with opportunities to capture and reflect on their own experiences of dealing with different language systems and to re-evaluate some of their content-related pedagogical decisions in light of the knowledge gained on the course. This paper compares the extent to which the assessment achieved these two intended learning outcomes in the academic years 2009/2010 and 2010/2011, as well as reporting on a case study investigating the in-depth reflections of two student teachers after the assessment in 2011/2012.

3.2 The student-teachers

Two sub-classes of student teachers were taking the language awareness course in 2009/2010 (i.e. 21 and 25 student-teachers in sub-classes A and B respectively) and 2010/2011 (i.e. 22 and 19 student-teachers in sub-classes A and B respectively). Although all the students from the two cohorts had been using different social networking sites such as Facebook to communicate with each other, they reported that they did not have any experience of building their own electronic portfolios. Many of them lacked the technical knowledge or skills for video editing, which was indeed a prerequisite for developing their electronic portfolios for the course. Most of them admitted that they had not heard about the University recommended portfolio building software, Mahara, before the course. Some student teachers from the 2009/2010 cohort were also found to be reluctant to log on to the new faculty e-learning platform, Moodle, from which they could access Mahara. Student teachers from the two cohorts were asked on various occasions for their comments on the electronic portfolio assessment implemented in the course, for example, the end-of-term teaching evaluation surveys and feedback sessions. However, because of the course design, these data were all collected before their portfolios were actually submitted and graded. Also, in 2011/2012, student teachers were invited to share with their tutors their in-depth reflections of the assessment about two months after they had been informed of their final grades of the course. As the tutors of sub-class A changed over the last few years, only the implementation process of the assessment in sub-class B was detailed and compared to maintain continuity. The patterns that emerged in the 25 and 19 electronic portfolios submitted by the student teachers in sub-class B in 2009/2010 and 2010/2011 are examined in detail below.

3.3 The 2009/2010 cohort

The 25 student teachers in sub-class B of the 2009/2010 cohort were given a large amount and various kinds of technical input to conduct the electronic portfolio assessment. Specifically, a technical staff member was assigned to support their electronic portfolio building process. Technical support in the form of Mahara user manuals, in-class demonstrations, and technical support hotlines was provided to help the student teachers to complete and submit their assignments. In each electronic portfolio, student teachers had to include two pieces of reflection detailing their teacher language awareness development, a brief contextual description of their teaching practice school, a few extended pieces of reflection on the course online forum, the teaching materials they used, the student compositions they marked and two content-related incidents that they had captured on video during their practicum. Although some difficulties were encountered, such as the tutors’ not being able to open some electronic portfolios properly, all the student teachers in the sub-class managed to submit their assignments before or shortly after the deadline.
Regarding the question of students’ perceptions of the new assessment in the end-of-term course evaluation survey, based on the 24 questionnaires returned from the whole cohort (i.e. 46), the electronic portfolio assessment was rated 3.13 on its usefulness on a 5-point likert scale, with 5 representing very useful. The result was somewhere between the highest rating, 3.63, for the course tutorials and teaching materials, and the lowest rating, 3.08, for the online discussion forum introduced into the course in the same year. In terms of student feedback, while some student teachers complained about the heavy workload of the course, others expressed the need to have clearer instructions for the assessment task. On the whole, the whole cohort of student teachers held rather negative opinions about developing their portfolios electronically and/or Mahara. One student stated in the questionnaire that the ‘non-text format [assignment] is not preferred’, while another considered things like video trimming ‘unrelated’ to their studies. All their comments on the electronic portfolio assessment are listed below:

Workload
- too much for the E-portfolio

Instructions for assessment
- need clearer instructions for assignments. Perhaps a sample/template.
- clearer guidelines are preferred
- guidelines about assignments are very unclear, not sure what I am expected to do

Mahara
- it might be more convenient to submit the video with DVDs than through Mahara
- Mahara is too difficult to use!

Developing the portfolio electronically
- trimming video and presenting in non-text format is not preferred
- should not expect Ss to do unrelated things e.g. trim videos, present artifacts in non-text format

Based on their format, the 25 electronic portfolios submitted by sub-class B can be grouped under five different categories (see Table 1 in section 3.4):

(1) all the files such as Word, video and PPT are uploaded as attachments to the electronic portfolio,
(2) one or more Word files are uploaded as attachments with the video files in the ready-to-show format as required,
(3) one or more Word files are uploaded as attachments with ready-to-show video clips, and images of student work and textbook materials being reflected on,
(4) text, ready-to-show video clips, and images of student work and textbook materials, and other enhanced features such as photos, graphics and sound effect.

In terms of the intended aims of the assessment, with only 17 student-teachers managing to present their ideas properly in their electronic portfolios (i.e. types 4 and 5), the research team believed that the primary aim to develop student teachers’ digital literacy through electronic portfolio assessment had barely been achieved. Only 2 electronic portfolios, among the 25 submitted, were, to some extent, technically enhanced, that is, included features that could not be integrated in traditional paper portfolios. One student teacher included in his portfolio a piece of self-composed music to remember the learning process he had gone through, while another integrated an animation showing a pen writing out her final self-evaluation of teacher language awareness in the portfolio. Regarding the development of the metacognitive awareness of the student teachers, based on the in-depth reflections of the declarative and/or procedural dimension(s) of teacher language awareness shown in the portfolios submitted, the aim to enhance the metacognitive awareness of the student teachers had been achieved.

3.4 The 2010/2011 cohort

Nineteen electronic portfolios were submitted by the student teachers in sub-class B in 2010/2011. In terms of content, the requirements for their electronic portfolios were exactly the same as those of the
2009/2010 cohort. However, support and preparation with different focuses (e.g. psychological, technical and methodological) were provided for this sub-class at different stages. In terms of psychological preparation, at the beginning of the academic year, the tutor went through the components and criteria of the electronic portfolio assessment with the sub-class, assuring them that they would be provided with all kinds of support they needed to build their electronic portfolios. Also, the tutor explained the significance of electronic portfolio assessment (e.g. to help develop their digital literacy), and why it had been adopted in the course, that is, to address the issue of storing different types of artifacts including video clips of classroom teaching, and to provide them with greater flexibility in terms of design and production of their electronic portfolios.

Regarding technical support, after the meaning of teacher language awareness had been explored and discussed student teachers in the sub-class were asked to write down their initial self-evaluation of teacher language awareness on a piece of patterned paper provided by the tutor. The reflections were then scanned, transformed into PDF files, and returned to the student teachers. The tutor then showed the sub-class how they could upload their PDF files onto Mahara to make their reflections the very first item required in the electronic portfolio. Most of the student teachers were indeed happy that they could follow the instructions easily, and they were encouraged to explore different uploading functions and presentation options on Mahara in their own time. They were also given short notes to guide their exploration and were encouraged to bring to the tutors any questions they had.

The student teachers were then methodologically prepared for the assessment. They were advised to create a specific folder and sub-folders to save up all the possible artifacts for their portfolios including drafts of their reflections. Specific attention was drawn to the importance of constantly evaluating, reflecting on and selecting appropriate artifacts for their portfolios over the period of the course. The tutor also highlighted the uniqueness and ownership of the portfolios, trying to help the student teachers to see the important and active role they played in the new assessment. Different learning activities involving self and peer evaluation were conducted to establish stronger links between course learning and their electronic portfolios. Towards the end of the course, the student teachers were asked again what specific technical support they would hope to have, and the requested support was given to the sub-class about one month before the deadline of the assessment.

All the student teachers in this sub-class managed to present their ideas properly in their electronic portfolios (i.e. types 4 and 5). Based on their format, the 19 electronic portfolios can be grouped under two different categories (see Table 1 below): (a) text, ready-to-show video clips and image(s) of initial self-evaluation of teacher language awareness (and teaching materials being analysed), and (b) text, ready-to-show video clips, image(s) of initial self-evaluation of teacher language awareness (and student work and textbook materials being analysed), and other enhanced features such as photos, graphics and sound effects. The submission process with some student teachers even submitting their portfolios days before the deadline as advised was smooth. The technician went through each submitted portfolio carefully, viewing all the files attached, before sending the student-teacher an email acknowledging receipt of the portfolio.

Regarding students’ perceptions of the new assessment in the end-of-term course evaluation survey, based on the 37 questionnaires returned from the whole cohort (i.e. 41), the electronic portfolio assessment was rated 3.22 on its usefulness, slightly higher than the year before (i.e. 3.13). In terms of student feedback, while some student teachers in the whole cohort continued to complain about the heavy workload of the course and to express their dislike of the electronic portfolio assessment, one piece of positive feedback was received from a student teacher who could see the benefit of doing portfolio assessment electronically, stating that this new format was ‘environmental friendly’. In fact, two student teachers told the tutor in their assignment feedback session that they had enjoyed the electronic portfolio building process and did not find it difficult. All the feedback collected from the end-of-term evaluation questionnaires is presented below:

Positive comment(s) on the assessment
- The electronic portfolio is environmental-friendly.

Negative comment(s) on the assessment
- I don't prefer using e-portfolio as the form of assessment as it is difficult to manage.
- I think submitting either hard copies of the portfolio or the e-portfolio could yield the same learning outcomes, and I could not see the advantages of submitting the final assignment as an e-portfolio instead of the hard copies.

- I think the electronic portfolio is very time consuming and it doesn't contribute to my learning of this course. I prefer handing in hard copy.

Table 1: Electronic portfolios submitted by sub-class B

<table>
<thead>
<tr>
<th></th>
<th>The 2009/2010 cohort</th>
<th>The 2010/2011 cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) All the files (Word, video and PPT) are uploaded as attachments to the electronic portfolio</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>(2) All the Word files (one or multiple) are uploaded as attachments with the video files in the ready-to-show format as required</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>(3) All the Word files (one or multiple) are uploaded as attachments with ready-to-show video files, and images of student work and textbook materials being reflected on</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>(4) Text, ready-to-show video clips, and image(s) of initial self-evaluation of teacher language awareness (and teaching materials being analysed)</td>
<td>9 *</td>
<td>6</td>
</tr>
<tr>
<td>(5) Text, ready-to-show video clips, and image(s) of initial self-evaluation of teacher language awareness (and teaching materials being analysed) and other enhanced features</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>19</td>
</tr>
</tbody>
</table>

* The video clips in one of the electronic portfolios in this category were not in the ready-to-show format.

As all 19 student teachers managed to present their in-depth reflections on teacher language awareness in their electronic portfolios properly (i.e. types 4 and 5), the research team believed that both intended learning outcomes of the assessment had been achieved in the academic year 2010/2011. In fact, three student teachers were able to enhance further their electronic portfolios by effectively using the multi-media platform provided. One student teacher included in his portfolio different short video clips of him introducing various components of the portfolio. Another included in her portfolio songs and video clips relating to her learning and teaching. Last but not least, a student teacher included a theme song and a flip book in her portfolio to summarize her final self-evaluation of teacher language awareness. The tutor was happy to see the improvements shown in this sub-class.

3.5 Gladys and Helena from the 2011/2012 cohort

The research/teaching team has long been aware of the possible impact of the anxiety that student teachers experience before submitting their electronic portfolios on their perceptions of the assessment. Therefore, in 2011/2012, student teachers of sub-class B were invited to share their views on the assessment with their tutor via email two months after they had been informed of their final grades. The seven open-ended questions listed below in relation to various aspects of the assessment were sent to the sub-class who had consented to allow the research team to analyse and disseminate the data they had provided. Among the 33 student-teachers in the sub-class, only 2 responded, although in great detail. The fact that the email was sent to the novice teachers just before the new school term could help explain the low response rate.

- How do you feel about the PCK electronic portfolio assessment NOW (e.g. after you have tried it)?
- We gave you different types of support before the assessment, i.e. psychological, methodological and technical support. Were you aware of that?
If yes, could you please give me an example to illustrate each type of support you received?

Do you think we should continue to implement the assessment in the language awareness course? Please explain your answer.

If yes, have you any suggestions for improvement?

Would you consider implementing this kind of assessment in your own secondary school classroom? Have you any preliminary thoughts to share?

Is there anything in relation to the assessment that you would like to share with me. 😊

While Gladys (pseudonym) responded to the tutor with a comprehensive list of reflections on the seven questions shortly after the email had been sent out, Helena (pseudonym) wrote to the tutor immediately after she received the email, telling the tutor that she would love to help, but she would need a bit of rest after an overseas leadership training programme. She took the initiative in setting a deadline for sending in her feedback. Together with her apologies, her detailed reflections were received a day after the deadline. In terms of their portfolios, with lots of technologically enhanced features including cartoons and animations, and in-depth reflections on various aspects of her teacher language awareness, Gladys’ portfolio (i.e. type 5) scored the highest in the sub-class. Helena, on the other hand, despite her in-depth reflections had hardly made effective use of the electronic platform to present her work (i.e. type 3).

The implementation of the assessment in 2011/2012 was basically the same as that of the year before, focusing on providing the student teachers with psychological, technical and methodological support. Similar to the previous cohorts, they were required to include two pieces of reflections detailing their teacher language awareness development, a formal essay describing their understanding of teacher language awareness, a brief contextual description of their teaching practice school, as well as a few pieces of reflection on the teaching materials they used, two content-related incidents they captured, and the course online forum. With an aim to reduce the workload of both the tutors and student teachers, hurdle requirements were introduced, with many of the items submitted this year, such as reflections on the online forum and school context, not being assessed in any way.

In terms of findings, unlike the feedback collected in the end-of-term evaluation surveys and feedback sessions before, both Gladys and Helena reported that they liked the new assessment format considering it creative, fun, interactive and stimulating. While Gladys reported liking its on-going nature best, Helena found the assessment fresh and creative:

As an assessment method, I find it quite fun and interactive. It allows us to use our creativity in organising our content and enriching the portfolio with visuals and audios. It is user-friendly. Furthermore, the assessment is on-going, as there are certain hurdle requirements that enable us to collaborate with our classmates, exchange thoughts and reinforce our knowledge and understanding throughout the course. This is way better than merely an end-of-semester essay as it helps to check our understanding throughout the learning process. (Gladys)

Yes, I think it's an interesting way to show what we’ve learnt during our Teaching Practicum (in terms of teacher language awareness). And it’s a fresh new creative idea that we can ask our own students to try. It's more stimulating as it's not only written text, but also videos, photos and songs etc. (Helena)

Both of them were well aware of the different types of support that the course provided. While Helena clearly remembered the time spent on preparing the student teachers technically and methodologically for the assessment, Gladys could clearly see the connection between the assessment and the pedagogical approaches adopted in the course:

Yes, I was aware of psychological and methodological support.
Psychological: I was in [tutor B’s] class, and she told us about this portfolio long before it was due and assured us that we would all be able to come up with a creative and informative portfolio.
Methodological: [Tutors A and B] spent nearly two hours (i.e. one whole session) to show us how to follow the steps listed. They patiently explained and demonstrated every step carefully, also welcomed questions.
I'm afraid I don't have comments about technical support as I didn't ask for it. But I'm sure if I did encounter technical problems and asked, [both tutors A and B] would be happy to help through emails. :) (Helena)

I agree with this statement. I remember that in the beginning of the semester, a lecturer was invited to teach us how to use the moodle forum. When Mahara was first introduced to us, [tutor B] also gave us clear instructions and demonstrations on how to use it. In addition, personally, I feel that the layout and instructions of Mahara are also reader-friendly. We can easily comprehend and use Mahara after exploring it for a few attempts. I also remember that [tutor B] arranged meetings with each group after marking our collaborative essays [on teacher language awareness to be included in our electronic portfolios]. This meeting and her feedback helped me clarify some misconceptions about the important terms, for example, KoL [i.e. knowledge of language], KaL [i.e. knowledge about language], and guided me to the right path in my later learning. (Gladys)

Moreover, their responses to the continuous use of the assessment in the language awareness course were positive. With a focus on students’ factors and understanding, Gladys’ suggestions are directly linked to the pedagogical approaches adopted in the course:

In my opinion, the E-portfolio can be continually used in the future and the hurdle requirements too, as they aid students’ ongoing understanding throughout the course. … I think the learning effectiveness of the E-portfolio also depends on, to quite a large extent, the attitude of the students. To be honest, our class is more of a receptive, passive nature, and we are not so eager to exchange our own understanding and knowledge in the lessons. This may have undermined the learning atmosphere and effectiveness of the class. Perhaps in the beginning of the semester, students can be reminded of the importance of contributing to the lessons and that there is no such thing as model answers, but how much they could learn would be determined by the amount of contribution they make in the class. (Gladys)

In line with the student factor that Gladys pointed out, Helena confessed that she had not made good use of the opportunity to enhance her learning:

I feel that there is a lot more that I could have done. I must admit that I started playing with the buttons and different functions a bit too late. I wish I had started on the day (or not long after) [tutors A and B] introduced us to the features. Due to limited time (which was caused by my own procrastination), I played it safe and didn't take full advantage of the available features to create an entertaining and comprehensive portfolio…. I noticed that a number of classmates and I had problems uploading videos directly onto the site. We ended up having to upload the files to YouTube and paste the link in our portfolios. Would be great if uploading files could be made easier. But then again, it was our own fault - not starting to try uploading files earlier (as [tutors A and B] advised us to). (Helena)

When asked if they would use the assessment in their own classrooms, both Gladys and Helena replied positively. However, being aware of the importance of student factors in this kind of assessment, Helena stressed that she might consider implementing electronic portfolio assessment with her self-disciplined and highly competent class only:

Maybe in a self-disciplined class with strong language and I.T. skills. (Helena)

4. Discussion

The findings show that the research/teaching team was so occupied with various technical challenges and issues in relation to the implementation of electronic portfolio assessment that they had not prepared the 2009/2010 sub-class psychologically and methodologically for the new assessment (Mok, 2011). Psychologically, they had not helped the student teachers see the underlying principle of the assessment, for example, allowing them much flexibility in capturing, presenting and storing their experiences in dealing with different language systems for reflection, and they had not, in any way, elicited from the student teachers their needs or concerns regarding the new assessment before or during the implementing process. Most importantly, they had not even explained to the student teachers why the portfolio assessment had to be done electronically. As a result, the student teachers were not prepared psychologically, in any way, for the new assessment experience.
Methodological ‘preparation [that] involves the acquisition of the necessary knowledge and techniques that will enable the learner to fulfil his role’ (Kolláth, 1996: 311) effectively in the new assessment was also not available to the student teachers in this sub-class. The various stages involved in electronic portfolio building (Kinnard, 2007) were not explained to them, nor how they could approach the assessment, for example, by saving all the possible artifacts in a designated place for further reflection and selection. The lack of methodological and psychological preparation could have contributed to some student teachers’ negative and insecure feelings about the assessment, as revealed in their feedback and portfolios (i.e. types 1-3). While some of them did not show any intention of composing their portfolios electronically, others seemed to lack the skills to do it effectively despite the tremendous technical support given to them. What is shown seems to reflect an attitude problem, that is, their lack of commitment in creating their portfolios electronically.

In terms of the psychological and methodological preparation that this sub-class could have needed, the recommendations that Hargreaves and Fullan (1998) make regarding taking advantage of the power of emotional resources of students to help them learn in the context of educational change could be applicable. These include getting students motivated by helping them understand the underlying principles of the new assessment, using different support strategies to raise their comfort level and involving them as much as possible in the change process. As in 2010/2011, the tutor explained explicitly to the student teachers the benefits and principles of the new assessment, helped them to build up their portfolios step by step in class and invited them to voice their concerns, especially the support that they would hope to have. All this preparation seems to have helped the 2010/2011 cohort to see the importance and advantages of doing the portfolio assessment electronically and better prepared them for the new assessment experience. A few student teachers even reported that they had seen the advantage of the new assessment and enjoyed the electronic portfolio building process.

In line with the importance of psychological preparation for student teachers, the reflections of Gladys and Helena reveal the crucial role that students play in this self-regulated assessment (Nichols and Dawson, 2012). Also, the teaching/research team was glad to see that both student teachers were aware of the close connection between the various pedagogical approaches adopted in the course and students’ engagement in the learning and assessment process (Hung, 2012), that is, constructive alignment (Biggs, 1999). The team has been trying to establish stronger links between the new assessment with the course curriculum and the faculty e-learning platform since 2010/2011, making the electronic portfolio assessment also assessment for learning tasks, for example, student teachers were invited to share their drafts of reflective essays for their portfolios and videos of microteaching on the e-learning platform to invite feedback from their group-mates and tutor. However, according to Gladys and Helena, there is certainly room for improvement. The team plans to integrate their feedback regarding peer review of portfolios and students’ contributions to the learning community into the design of the course in the future.

5. Conclusion

This case study reveals that the student teachers in 2010/2011 were better prepared psychologically, technically and methodologically than those in 2009/2010 regarding the electronic portfolio assessment, which in turn maximized its learning potential. The findings point to the need for teachers to be aware of the importance of student preparation in the implementation of assessment innovations (Mok, 2011). The study, although exploratory, has important implications regarding the implementation of electronic portfolio assessment. First of all, various types of student support, for example, psychological, methodological and technical, may be needed to prepare students for the experience and to help them to perform effectively in the assessment. Secondly, deep pedagogical approaches need to be adopted to align constructively with the assessment in order to maximize students’ engagement in the self-regulated assessment and learning process.

In terms of educational and/or assessment innovations regarding e-learning, the study shows that it is important for the implementer to understand that technical support is not all that learners need. Also, on top of the various types of preparation, it takes time for the learner as well as the implementer to reflect on and understand the innovation, as the research/teaching team has done during the past few years. Last but not least, it is important for teachers to put learners’ experience at the heart of the change process, for example, by listening to the concerns they have about the change. The team is well aware of the limitations of the study, such as the limited data collected from Helena and Gladys. Future research on the implementation process of e-learning innovations and specifically, its
connection with students’ engagement could help maximize the learning potential of the assessment. This paper hopes to facilitate further exchanges of ideas and reflections on the use and implementation of electronic portfolio assessment in the educational context.

References


Acknowledgement

The research team hopes to thank the Teaching Development Grants of the University of Hong Kong for supporting the introduction of the assessment innovation and implementation of the study.
Multi-disciplinary Learning through a Database Development Project

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Abstract: Recently, there are many good examples of how multi-disciplinary learning can support students to learn collaboratively and not solely focus on a single professional sector. During the Fall 2011 and Spring 2012 semesters, we have attempted to gather students studying different professional domains together. Students from the Department of Computing (COMP) and the School of Hotel and Tourism Management (SHTM) are involved as partners and team members to work on joint student projects. One group of SHTM students is planning a conference event in 2012 with over 300 guests. These students act as the clients who require a banquet management system as well as a delegates managing application. Another group of SHTM students is to manage the development projects with the support of IT consultants who are in fact the COMP students. During the Fall semester, different communication channels have been set up to facilitate the inter-group and intra-group communications with the support offered by an e-learning system, Blackboard. Furthermore, there are classroom presentations given by the SHTM students and prototype demonstrations prepared by the COMP students. Pre-project and post-project questionnaires have been given to all participating students in order to assess their gain in professional and business knowledge in 2 different areas, namely database application development and conference management. During the Spring semester, another group of COMP students continued the development and made the 2 systems available on the Web. The two systems were used in a real conference and have received many positive feedbacks. In this paper, we would like to report the group dynamics of our students, achievement and difficulties encountered in this multi-disciplinary project.

Keywords: Multi-disciplinary Learning, Teamwork, Database Application Development

1. Introduction

In designing software engineering course materials, teacher would like to relate the “hard” facts back to the real world situation especially for senior year students preparing for their job hunting. What kind of skills companies want? For many companies, IT students are expected not only having technical skill but also other "soft" techniques like communication skill, creativity and entrepreneurship so as to cope with the rapidly-changing business environment (Žagar, Bosnić & Orlić, 2008). A product-based learning approach was taken on a Java course to the computer-science and software engineering students in United State (Ragan et al, 2009). For database application developments, one of the main issues to learn is focusing on the ‘client-centredness’. Domínguez and Jaime (2010) from Spain had launched a database design course following the ideas of PBL and applied an enterprise-oriented work environment during the whole process including deadlines, limited resources, penalization for delays, role-playing, documentation production and checking, etc. Apparently, for better learning results, there is a need to find appropriate clients for students to appreciate and acquire the real world requirements of a development project. After realizing the issue, a multi-module software engineering term project involving different subjects has been set up for year 2 students studying in the Department of Computing. In Fall 2006, a simulated environment with business cases of a company had been introduced and colleagues were asked to act as external clients for giving requirements during interviews. Students gave very positive feedback because they considered, through the arrangement, they have learned communication skill and business knowledge, which were quite difficult to acquire in traditional lectures and tutorials. Because of the intensive resource demand, during 2008-2010, a virtual company was built inside an online world (Second Life) to cope with the large number of student projects. However, for these 3 years, student feedbacks were mixed due to the issues of artificial intelligence support in Second Life.

A team is a small number of people with complementary skills who are committed to a common purpose, performance goals and approach for which they hold themselves mutually accountable (Katzenbach & Smith 1993). Tjosvold’s (1989) model of cooperative dynamics in organizations...
suggested that cooperative interaction improves productivity. Through team working, people can be more motivated to apply their learned knowledge. In the report from University of Glasgow, it presents four main factors supporting multidisciplinary teamwork – committed individuals who play a key role in team development, staff with a common sense of purpose or vision and who work together to achieve it, clearly negotiated team roles, and explicit support for such developments at the organizational level (Wilson & Pirrie 2000). For different types of multi-disciplinary learning activities, multi-disciplinary team working is well-established in the literature of health and social care. Based on the study of Patrashkova-Volzdoska (2003), in a cross-functional team communication, the communication frequency can have a curvilinear relationship to team performance instead of a straightforward relationship commonly believed.

Interest in multi-disciplinary team working has been existed for many years (Mathias & Thompson 1997, Barr et al. 1999 & Riebe et al. 2010). Multi-disciplinary learning brings different groups of people with complementary backgrounds to work together (Wicklein & Schell 1995). We have found example in Statistics course collaborated with other subjects (Ojeda & Sahai 2003) and another example of inter-disciplinary/cross faculty collaboration done by Pan et al. (2010) where the Industrial and Manufacturing Systems Engineering Department and the Faculty of Education within the same institute created a joint project to re-purpose an eLearning system to serve the education students’ need in relation to teaching practice. This form of learning can break down traditional barriers between students of different disciplines and empower them to appreciate non-familiar professional knowledge (Hoare et al. 2008). It can promote problem solving, with input from a wide variety of view points and different knowledge aspects. For undergraduate education, it has long been known that we need to produce graduates with a strong cross-disciplinary outlook as many significant advances have been resulted from interactions between different fields. Recently, Hayhurst et al. (2011) has discussed how well-established management subjects and appropriately structured group projects can enhance the multi-disciplinary learning of engineering students. We need students having division specific knowledge and skills as well as how to working with others. The development of multi-disciplinary course is essential as the real world is complicated.

2. Motivation

In 2010, the new Hong Kong Polytechnic University training hotel, Hotel Icon, had open for authentic student learning. One of its objectives is to support a series of integrated student learning activities that will be built through collaboration between School of Hotel and Tourism Management (SHTM), Department of Computing (COMP), Institute of Textile and Clothing (ITC) and Department of Applied Biology and Chemistry Technology. Students will be able to work towards specific subject learning outcomes while not limited by traditional departmental bounds and allow to have a shared teaching and learning context that will be both challenging and innovative. For example, student projects in the School of Hotel and Tourism Management (SHTM) designing hotel facilities may find the results of the testing, experiment and material collection of Institute of Textile and Clothing (ITC) student projects acting as inputs for the projects of SHTM students. The purpose is to enable students not only benefit from getting new experiences but also new ideas through interactions with peers in other disciplines. This paper reports our experiences on providing students term projects for database application with multi-disciplinary team working. We hypothesize:

\[ H1a. \text{ COMP students will gain event and convention management knowledge from the SHTM students through the project.} \]
\[ H1b. \text{ SHTM students will gain database system development knowledge from the COMP students through the project.} \]
\[ H2. \text{ Students will achieve better learning outcomes through the project.} \]
\[ H3. \text{ Students will achieve better teamwork and communication skills through the project.} \]

Learning should be a constructive, self-directed, collaborative and contextual process between students of different disciplines. Section 1, the introduction, presents the background and we elaborate the motivation of our work in Section 2. It is followed by the methodology that we have adopted in section 3. Section 4 discussed our findings and feedbacks from students. Finally, in Section 5, we will conclude the paper and discuss problems encountered and future enhancement. Our studies focus on the collaborative learning principle and through a better understanding of why and under what circumstances these theories or concepts work or not work, we hope our study could
be considered as an example of one which contributes towards the collaboration learning theory building.

3. Methodology

In Fall 2011, the Hotel Icon Project is launched to enable authentic and collaborative multidisciplinary learning experiences for students in The Hong Kong Polytechnic University. The project has a number of sub-projects which are servicing students from different combinations of academic departments and schools. One of the sub-projects is to support the multi-disciplinary team working for students in SHTM and COMP. Here, different students will have different roles (end-users, vendors, developers) in database application development projects.

The SHTM students acted as end-users to present and explain the business needs, and later analyze and critique existing problems in a business application. Another group of SHTM students acted as vendors (or consultants) to evaluate the selection of appropriate technologies for the respective business application. The COMP students were developers to apply the principles of database design to a real life problem and be responsive to know the impact of the database system developments to the industrial. Overall, all students could benefit from working together as a team, gain better understanding of different roles and the nature of group dynamics, develop effective communication and critical thinking skills, and design alternatives solution in a group setting.

A class of SHTM students (Group A, Special Event Project I) were asked to help in organizing the International Convention & Expo Summit 2012 (ICES2012) and the 11th Asia Pacific Forum for Graduate Students’ Research in Tourism (APFGS2012). The whole class will become the organizing committee of the 2 conferences and each student has gone through a recruiting process for a duty assignment. Another group of SHTM students (Group B) who studied ‘Special Topics in Convention and Events’ and COMP students who studied ‘Foundations of Database Systems’ are also involved.

After several rounds of discussions with participating lecturers, two business applications for the conference have been identified as below.

- The Banquet Managing System should be able to
  - Collect information specific to the event with the ability to accommodate several hundreds of users and thousands of records in an easily scalable manner;
  - Keep track of the meal selection and seating arrangement;
  - Provide information for the catering services.

- The Delegates Monitoring System should be able to
  - Collect information specific to the event with the ability to accommodate several hundreds of users and thousands of records in an easily scalable manner;
  - Manage meeting related information like the session topic, meeting location and attendee response etc.;
  - Allow the organizing committee to know and track on the meeting sessions’ “people flow”.

Group B students and COMP students would serve as development consultants and developers; while Group A students would provide business requirements as a wish list to the COMP students. Figure 1 shows the relationships and the activities of this multi-disciplinary student project for the 3 groups of students.

In Fall 2011, for the multi-disciplinary term project, there were 115 COMP students from the Foundations of Database System subject; 25 SHTM students from the Special Event Project I subject (Group A) and 11 SHTM students from the Special Topics in Convention and Events subject (Group B). Group B SHTM students would act as systems’ liaisons in the project. They needed to communicate with their customers and collect the business requirements. After their own digestion, they should convert the business needs into the system requirements and then pass them to the COMP students, the developers, who needed to develop a database application as the final product. The breakdown of the student roles is shown in Table 1.
3.1 Student Participants and Roles

<table>
<thead>
<tr>
<th>Class</th>
<th>Group B</th>
<th>Group A</th>
<th>COMP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role</td>
<td>Liaison</td>
<td>Customer</td>
<td>Developer</td>
<td></td>
</tr>
<tr>
<td>Number of Active Students</td>
<td>11 (3*)</td>
<td>25</td>
<td>115</td>
<td>148</td>
</tr>
</tbody>
</table>

*Among the 11 students from HTM3114, 3 of them also took HTM4117.

Table 1: Participants Summary

3.2 Project Arrangement

Group A students were further divided into 5 different teams. During the first week, each team had to come up with a wish list for the two systems: Banquet Managing System (BMS) and Delegates Monitoring System (DMS). The BMS should be able to collect information specific to the event with the ability to accommodate several hundreds of users and thousands of records in an easily scalable manner; keep track of the meal selection and seating arrangement and provide information for the catering services. While, the DMS should be able to collect information specific to the event with the ability to accommodate several hundreds of users and thousands of records in an easily scalable manner; manage meeting related information like the session topic, meeting location and attendee response etc. and allow the organizing committee to know and track on the meeting sessions’ ‘people flow’.

A wish list presentation was given to the Group B students in week 2 of the semester. The two teams of Group B students who acted as the systems’ liaisons needed to consolidate the wish lists from all the teams of Group A and write out a business requirement plan for each system. The plans were then passed to the COMP students. In addition, two rounds of business presentations were given to the COMP classes by the Group B BMS team and DMS team, respectively. At the same time, a forum discussion section was opened up in Blackboard (a Learning Management System). The 115 COMP students were divided into 31 teams with 19 teams working on BMS and 12 teams working on DMS. In week 7, the 31 COMP teams had to submit their system design documents which would be reviewed by the Group B BMS and DMS teams. After received the feedback, the COMP teams got around 3 weeks to build a prototype of the application. They had to demonstrate their prototypes to the Group B BMS and DMS teams in week 12 as shown in Figure 2. Based on the demonstrations and screen shots, the two Group B teams would provide suggestions and recommendations to the Group A class through a presentation with all the pros and cons listed and supporting reasons given. Finally, the Group A class would select one application for each system to be adopted afterwards. Figure 3 summaries the flow of the project arrangement.
3.3 Feedback collection

In order to make the comparisons before and after the multi-disciplinary student project arrangement, a pre-project questionnaire and a post-project questionnaire were given to all the active students in week 2 and week 14 during their lecture classes. The questions are designed with the consideration of the four main factors supporting multidisciplinary teamwork from the report of Wilson et. al. from University of Gasgow (Wilson & Pirrie 2000). There were 10 questions concerning the level of confidence in the knowledge of relational database, hotel and tourism management and their pass experiences on database development and convention organization. Another set of 15 questions were related to the objectives and expectations of the students. Besides, we also wanted to find out what were the student comments on the usage of different communication methods like the face-to-face meeting, online forum discussion etc.. Most of the questions were in Likert scale (1 is strongly disagree and 5 is strongly agree). 107 pre-course questionnaires were collected and 134 post-course questionnaires were collected. 93 students had done both set of questionnaires.

To enrich our data and gather more feedbacks, we also performed several interviews with a selected group of students in the middle of as well as at the end of the semester. Questions concerning the likeliness, usefulness, communication and planning with other departments were asked during the interviews.
3.4 Web-based Versions

The first versions of the 2 systems (Banquet Managing System and Delegates Monitoring System) have been completed by the end of Fall 2011. We continued to organize COMP students in another subject (Introduction to Internet Computing) to enhance them as term projects. Additional requirements and details are collected from SHTM students taking the Special Topics in Convention and Events subject. Two of the developed web-based systems from the term projects were put into real operation in a SHTM conference.

4. Findings and Discussion

We have tried to assess the success of the multi-disciplinary joint projects with 2 main types of instruments, quantitative surveys and focused group interviews with students. The following sections described what we have observed.

4.1 Questionnaire Surveys

Each pre- and post-questionnaire contains 63 different questions covering different aspects, including level of confidence of different domain knowledge, learning outcomes of respective subjects, inter-group dynamics among students from different disciplines, and communication channels.

4.1.1 Domain Knowledge

For domain knowledge, we asked 3 questions concerning the relational database and 3 questions concerning the hotel and tourism management. The result was shown in Table 2. Comparing the results, the COMP and SHTM students got a similar pattern. Both of them indicated the improvement in their own area of knowledge (either database or event and convention management) and their counterpart’s area knowledge. The result on the knowledge gain from both groups is encouraging. The gain in the domain knowledge supported our hypothesis H1a and H1b.

<table>
<thead>
<tr>
<th></th>
<th>Students of COMP</th>
<th>Students of SHTM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Mean)</td>
<td>Pre-course</td>
</tr>
<tr>
<td>Knowledge in Relational Database</td>
<td>3.11</td>
<td>3.74</td>
</tr>
<tr>
<td>Knowledge in Hotel &amp; Tourism Management</td>
<td>2.29</td>
<td>3.12</td>
</tr>
</tbody>
</table>

Table 2: Level of Confidence before/after the project

4.1.2 Expectation and Learning Outcomes

For the analysis of H2, we calculated the mean scores of questions on learning outcomes (lo) and expectation (ep), both COMP and SHTM groups have lower scores in the post-course questionnaire (COMP lo/ep: 3.7/ 3.7; SHTM lo/ep: 3.9/ 4.1) than those in the pre-course questionnaire (COMP lo/ep:3.9/ 4.0; SHTM lo/ep: 4.3/ 4.4). Then, further analysis was taken on the 93 set of questionnaires done by the same subjects (the students). It is found that students gave a high expectation in the pre-course questionnaires frequently do not have much gain on satisfactions in the post-course questionnaires.

We performed further analysis and have divided the 93 students into 5 different groups according to their roles, backgrounds and their degree of involvement in the joint project as shown in Table 3. The group of students taking both the customer and liaison roles (SHTM-AB) had the highest degree of involvement. The next group was the group taking the liaison role (SHTM-B). Both groups needed to follow through the whole project from start to end in gathering the business requirement, presenting the requirements, answering the question from the developers, giving comments on the prototype demonstrations and suggesting recommendations to the customer. The group of students taking the customer role (SHTM-A) only got involved during the beginning of the semester on creating the wish list and at the end on selecting the final applications. For the developer groups, we divided them into
two sub-groups. The first sub-group (COMP-A) took more business and management training and the second sub-group (COMP-B) was only keen on the technology.

The paired-samples t-tests were done comparing the pre and post results against each group for verifying H2. It was found that each group got the statistically significant positive feedback on different aspect. More positive feedbacks were given by the groups with higher degree of involvement.

<table>
<thead>
<tr>
<th>Group (No of students)</th>
<th>Role &amp; Background</th>
<th>Degree of Involvement</th>
<th>Questions with Positive feedback (under Paired Samples t-test significant &lt;.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHTM-B (7)</td>
<td>Liaison</td>
<td>High</td>
<td>– Learnt from students of other disciplines &lt;br&gt;– Strengthen on communication skills &lt;br&gt;– It was a good learning experience &lt;br&gt;– Worked efficiently and effectively</td>
</tr>
<tr>
<td>SHTM-AB (8)</td>
<td>Customer and Liaison</td>
<td>Highest</td>
<td>– Given the chance to apply learning to a real problem &lt;br&gt;– Communication with teams using different communication channels &lt;br&gt;– Carrier out a task with well-defined objectives and outcomes &lt;br&gt;– Developed an application which can be use in real business</td>
</tr>
<tr>
<td>SHTM-A (16)</td>
<td>Customer</td>
<td>Low</td>
<td>– Developed an application which can be use in real business</td>
</tr>
<tr>
<td>COMP-B (27)</td>
<td>Developer Background leaning towards business side</td>
<td>Medium</td>
<td>– Gained new knowledge benefit future jobs &lt;br&gt;– Provide prompt input to the project &lt;br&gt;– Able to plan and management time to complete task and achieve goals &lt;br&gt;– Developed an application which can be use in real business</td>
</tr>
<tr>
<td>COMP-A (35)</td>
<td>Developer Background leaning towards technology side</td>
<td>Medium</td>
<td>– Given the chance to apply learning to a real problem &lt;br&gt;– Carrier out a task with well-defined objectives and outcomes</td>
</tr>
</tbody>
</table>

Table 3. Paired Samples t-test on Expectation and Learning Outcomes

4.1.3 Student Communications

Different communication means have been used to support the interactions between students, in particular, the Blackboard Learning Management System which the University has been using since Fall 2011. It supports forum, wiki, blog, email and online chatting.

<table>
<thead>
<tr>
<th></th>
<th>Necessary</th>
<th>Helpfulness</th>
<th>Likeness</th>
<th>Recommend to future project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackboard</td>
<td>COMP n/a</td>
<td>n/a</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>SHTM n/a</td>
<td>n/a</td>
<td>3.5</td>
<td>3.4</td>
</tr>
<tr>
<td>Forum discussion (in Blackboard)</td>
<td>COMP 3.7</td>
<td>3.6</td>
<td>3.4</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>SHTM 4.2</td>
<td>3.9</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Videos</td>
<td>COMP n/a</td>
<td>3.4</td>
<td>n/a</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>SHTM n/a</td>
<td>3.9</td>
<td>n/a</td>
<td>3.9</td>
</tr>
<tr>
<td>Classroom face-to-face interaction</td>
<td>COMP 4.0</td>
<td>3.9</td>
<td>3.9</td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td>SHTM 4.3</td>
<td>4.3</td>
<td>4.2</td>
<td>4.3</td>
</tr>
<tr>
<td>Inter-group face-to face interaction</td>
<td>COMP 3.9</td>
<td>3.9</td>
<td>3.8</td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td>SHTM 4.3</td>
<td>4.5</td>
<td>4.2</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Table 4: Evaluation Results of Students using Different communication channels

Table 4 shows the evaluation results from the students on the different communication channels. It is interesting that both groups of students prefer to have more face-to-face interactions than communication through the other means.
4.1.4 Group Dynamics

Group process is not in a linear sequence. During different periods of the student project, a group may engage in different kinds of decision making process and problems to be addressed. The communication within groups in each stage of Tuckman’s (1965) group development model could be in various forms. In the case of inter-group scenario, the groups shall go through the forming, storming, norming and performing stages as well. However, each stage takes time to process and then carriers on. The group interactions on the intra- and inter-group development process are presented as in Figure 4.

Figure 4: Intra- and Inter-group development model

For the analysis of H3, in the pre-course questionnaire, we asked 8 questions concerning the intra-group dynamics. It was found that most students were familiar with group project or group work and they known their team members in advance (COMP M=3.5, SHTM M=4.1).

<table>
<thead>
<tr>
<th></th>
<th>Diff. on Mean</th>
<th>Diff. on Std. Deviation</th>
<th>t</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.020</td>
<td>1.116</td>
<td>.180</td>
<td>.857</td>
</tr>
<tr>
<td>2</td>
<td>.111</td>
<td>.891</td>
<td>1.241</td>
<td>.218</td>
</tr>
<tr>
<td>3</td>
<td>-.121</td>
<td>.961</td>
<td>-1.255</td>
<td>.213</td>
</tr>
<tr>
<td>4</td>
<td>.091</td>
<td>.834</td>
<td>1.084</td>
<td>.281</td>
</tr>
<tr>
<td>5</td>
<td>.081</td>
<td>.911</td>
<td>.882</td>
<td>.380</td>
</tr>
<tr>
<td>6</td>
<td>-.030</td>
<td>1.199</td>
<td>-.251</td>
<td>.802</td>
</tr>
<tr>
<td>7</td>
<td>.141</td>
<td>.979</td>
<td>1.437</td>
<td>.154</td>
</tr>
<tr>
<td>8</td>
<td>.162</td>
<td>1.037</td>
<td>1.550</td>
<td>.124</td>
</tr>
</tbody>
</table>

Table 5: Paired Samples t-test on Group Dynamics

In the post-course questionnaire, we asked the same 8 questions but concerning the inter-group dynamics this time (COMP M=3.5, SHTM M=3.9). From the results shown in Table 5, both groups
rated the intra- and inter-group dynamics questions without significant difference statistically. In this multi-disciplinary student project, the time allowed for interaction was limited. We had encountered students with intra-group conflicts during the semester but it seems there were not many complaints on the other side (students from the other discipline). The post-course questionnaire shows a friendly and peaceful scene. Conflict in groups occurs over task issues as groups begin presenting their ideas (Harris & Sherblom 2008).

### 4.2 Focused Group Interviews

There were 2 rounds of interviews conducted. One was in the middle of the semester with COMP students and the second one is towards the end of the semester with SHTM students. Four main questions have been asked during the interviews as follows:

- What do you like the most about the multi-disciplinary project?
- What were the challenges?
- What you had learnt from the multi-disciplinary project?
- Do you have any suggestions to make the project better?

Some of the answers from COMP students are quoted below.

"The cooperation is kind of like through real world practice that we don't have opportunities in our own courses. Because we never have such 'real' experience to the business, the company requires us to do such a project."

"Our problem is miscommunication, because we don't really get a chance to always meet the hotel students or really get a face-to-face meeting together. Sometimes, we misunderstood their meaning and sometimes they couldn't tell why we are doing."

"We have no idea how a banquet will be ran in a hotel. The work with SHTM students can expand our horizon, a really good chance for us to learn new things."

Some of the answers from SHTM students are quoted below.

"It is just like a bridge to let us to learn how to discuss and then I think this is great for our future career."

"The most difficult is to understand their prototype, because we don't know what it is about or maybe I don't know much on computer languages."

In summary, during mid-term interviews with COMP students, they reflected that they were not sure how to tackle the project at the beginning. They needed to repeatedly read the documents and discussed with the tutors before getting a better idea of the work, which may have discouraged them. Some students raised the concern about the assessment. Especially, they were not sure how they should be reacted when there were conflicts between the requirements from the SHTM students and the subject lectures as the requirements were given by the SHTM students while the grading was done by the subject lecturers.

For the semester-end interviews, SHTM students commented on the necessity of the face-to-face discussion rather than in an electronic form. They found interactions with Blackboard and / or forum discussion was not the ideal way of communication because timely responses and diagrams were often needed. Also, the workload of the joint project was much higher than expected though the whole process was very interesting. However, the time and effort being spent on the discussion, evaluation and organization were at least double when compared with other SHTM students working on other projects but in the same class.

In both interviews, students have noted that there are differences when they interact with students from the other disciplinary but that there are also seminars.
1. Conclusions

This paper discussed the motivation and arrangement on a multi-disciplinary team working approach for students coming from different disciplines. In Fall 2011, we have gathered students studying different professional domains together to work on a joint term project. Three groups of students from the Department of Computing (COMP) and the School of Hotel and Tourism Management (SHTM) are involved. The first group of SHTM students acted as the customers who are required to spell out the specifications of a banquet management system as well as a delegates managing application. The second group of SHTM students was asked to manage the development projects and the third group was COMP students acting as IT consultants.

Pre-course and post-course questionnaires have been given to all participating students in order to assess their gain in professional and business knowledge in 2 different areas, namely database application development and conference management. In our preliminary findings, it has been observed that the 2 groups of students have improved their knowledge in both domain areas. Yet, the high expectation beforehand has not led to a high rate of satisfaction. It is observed that the higher the degree of involvement to the project, the higher the overall learning outcomes result. That is more work, and more gain. Also, it is interesting that students are in favour of face-to-face interactions when we consider electronic means were their natural choices. Students achieve better team working and communication skills through the project. For group dynamics analysis, there is no significant difference between intra- and inter-group observations while students have reported difficulties in communication during focused group interviews. We would need to re-design the questions for more accurate feedbacks in future.

After the Fall 2011 semester, the same projects were given to another group of COMP students. They are asked to complete the web-based versions as their term project in Spring 2012. The finishing products were put in real use of a SHTM conference held in May 2012. Many positive comments have been received. For example, the Department of English is interested in implementing the QR code
related modules in another conference held in Nov 2012; a university from Bangkok would like to modify the two applications and use them in their hosted conference in 2013.

References


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Abstract: This paper describes a framework for measuring student learning gains and engagement in a Computer Science 1 (CS 1) / Information Systems 1 (IS 1) course. The framework is designed for a CS1/IS1 course as it has been traditionally taught over the years as well as when it is taught using a new pedagogical approach with Web services. It enables the new approach to be compared with the traditional way of teaching the courses in terms of student self-assessment of learning gains, student assessment of their engagement with the subject matter, and researcher assessment of student learning gains as measured by performance on a researcher-designed examination. The framework includes a comprehensive pre-test and post-test for students in the control and treatment sections to complete, a common assessment exam module for all students to take, and a faculty survey for the instructors to complete. This enables the researchers to answer many questions regarding the effectiveness of the Web service approach, including “Do students using the Web service approach perform better in the common assessment exam module?” and “Do students and faculty members find the Web service approach more engaging?” Results from the first semester of a 3-year multi-university study are discussed.

Keywords: learning gains, introductory computing course, web services, learning engagement, SALG

1. Introduction

The topic of the measurement and evaluation of a teaching technique is important for all learning paradigms. Measuring and evaluating the success of a pedagogical approach in any project is crucial as it allows one to determine if the given approach is indeed effective, with objective measures to accompany the claim. As it is often quoted, “If it can't be measured, it can't be managed” (Deming, 2012).

In a recently completed 2-year pilot research project (Lim and Hosack, 2009) at a large Midwestern university in the United States through a National Science Foundation grant, there was a clear need for a measurement and evaluation model so that the new pedagogical approach could be properly managed and assessed. In the project, the researchers were trying to assess the effectiveness of a newly devised pedagogical approach for teaching Computer Science 1 (CS1) / Information Systems 1 (IS1), the introductory computing course for computer science and information systems majors respectively. Specifically, the project was to examine CS1/IS1 courses as they had been traditionally taught over the years as well as how they were taught using a new pedagogical approach with Web services technology. Namely, the main objective of the pilot project was to measure the effectiveness of the newly proposed service-oriented paradigm to teaching CS1/IS1 in terms of student exam performance. The promising results achieved in the exploratory study encouraged the researchers to expand the study and now branch out to multiple universities so that the approach can be tested in various sites for its effectiveness using the new framework for instruction and its assessment.

The Web service approach to teaching CS1/IS1, an approach that integrates the use of burgeoning Web services technology throughout the courses, has been shown to increase student performance in the final exam score in a recent study. The approach is also more interesting to the students as it allows for more sophisticated apps to be built, where students can build mashups that involve Google Maps, YouTube, Twitter, etc. in their first programming course.

The burgeoning Web service technology and the approach for using it in teaching CS1/IS1 are recapped in Section 2 of this paper. And, as detailed in Section 3, the model used for assessing the approach is an effective one. The Web service approach has been shown to allow students to
perform better in a common final exam (Hosack et al., 2011). A great deal was learned from the pilot project, including some shortcomings/pitfalls on the assessment model as we planned for expanding the approach to include multiple sites. Based on the pilot study, three improvements can be considered by researchers facing similar situations when testing a new pedagogical approach. The assessment model from the pilot study was revised into a new framework that is more standardized and comprehensive can be established are described below. This framework is currently being tested in an expansion study (Lim and Hosack, 2011) that involves multiple institutions given the initial evidence of success in the pilot study. The three improvements are categorized below.

First, the original instrument for assessing student learning gains was developed in-house and not based on a standardized, widely used instrument that has been tested extensively. To address this, a revised instrument that is based on SALG (Student Assessment of Learning Gains) (Seymour et al., 2000, www.salgsite.org) has been developed. SALG is a nationally validated pre- and post-survey of students’ self-assessment of their knowledge before and after a course. Because it has been used in numerous courses over many years, it can provide the basis for measured comparisons of student learning. SALG initially targeted the field of chemistry but has since been generalized to work with various disciplines. For example, Anderson (Anderson, 2006) uses SALG in the Nutrition and Food Science area. The SALG instrument can be adapted to address a particular set of skills, in this case computer programming, while retaining its reliability and validity.

Second, while measuring student learning gains was an objective of the pilot project, measuring student engagement was not. Given the nature of Web services, which allows for the wealth of information on the Web to be harvested easily through API (application programming interface) calls from one’s computer program, it would be remiss for the new framework not to capture student engagement. Students are expected to be more engaged with the Web service approach as they are interacting with activities that they often personalize to make them more interesting and relevant (e.g., find all 3D movies that are playing in my hometown (zipcode xxxxx), display all comments from my favorite YouTube video, etc.).

There have been many different efforts in the literature on engaging student learning using a variety of approaches. They include the application of “gamification” to eLearning to engage learners where the theory behind gaming design is applied to build engagement interactive materials such as eLearning (Raymer, 2011), the study of how learning community participation affects student engagement (Pike et al., 2011), the research on curiosity, interest and engagement in technology-pervasive learning environments (Arnone, 2011), just to name a few. The proposed framework allows the researchers to assess whether the Web service approach represents another means to actively engage students in learning the fundamentals of computer programming.

Third, the assessment model was applied to one institution only when the pilot research project was conducted. In the expansion project that involves multiple, collaborating institutions, a framework that supports the assessment on multiple sites is desirable. The proposed framework includes a common assessment exam module, approved by the instructors involved, that allows for comparisons across universities. Also, instructors’ own reactions to the new method of teaching programming are measured.

The paper details a framework for measuring student learning gains and engagement in an introductory computing course. The framework allows for a new pedagogical approach to teaching CS1/IS1 to be measured against the traditional approach that has been used for many years. Data such as student self-assessment of learning gains, actual gains in exam performance, and student engagement can be captured for analysis. It is the framework used in a longitudinal study that provides methodological insight into student learning using the new learning paradigm. Together with the framework, the results from the first semester of a 3-year multi-university study are also discussed.

The remainder of the paper is organized as follows. Section 2 recaps the Web service approach to teaching introductory computing course. The assessment model used in the Web service approach is described in Section 3. Section 4 discusses the new framework that improves on the one used in the pilot study. A discussion of the implications of the framework is presented in Section 5. Finally, the summary and conclusions are given in Section 6.
2. Web service approach to teaching introductory computing

Web services technology is a burgeoning technology that has received tremendous amount of attention in the software industry. After mainframes in the 60s, PCs in the 80s, applications in the 90s, and the Internet in the 00s, Web services have been considered a disruptive technology based on the 5th wave of computing. According to Gartner, a reputable research firm, in its “Hype Cycle for Application Architecture, 2010” report (Gartner, 2010), basic Web services are plotted on the “plateau of productivity” portion of the curve, which Gartner defines as a state that “…real-world benefits of the technology are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generation” (Table 1).

Given the importance of Web service technology, it is imperative that the technology be introduced in today’s IT curricula. Also, the researchers have shown that Web services can be integrated into the curricula early, i.e., in introductory computing courses (Lim et al., 2005). As a result, this research targets CS1 and IS1, courses that are designed to introduce the basic problem solving and program design skills that are used to create computer programs. The objective is to stimulate student learning of the materials by not introducing concepts in an abstract, boring, and contrived fashion. Instead, the emphasis is on developing modules/scenarios that are creative, novel, and engaging. The key idea is to develop a module that when presented to a student, he/she would think: "let's see what happens when I try ...."

To give a sense of how the Web service approach is used, a sample module comparing the Web service and traditional approaches for a typical topic covered in CS1 or IS1 is presented in Table 1 below. This topic, along with various other topics, can be easily enhanced so that students are exposed to the state-of-the-art technology. The topic is presented with a typical delivery mechanism using the traditional approach, then augmented with the Web services approach, and finally followed by an example depicting the Web service approach to the topic.

In the following selected module, the topic presented is “Sequence, Iterative, and Decision Structures.” The learning objectives aim to reinforce the concepts behind the fundamental control structures of sequencing, looping, and decision making. Upon completion of this module, students should be able to ascertain the order in which the various tasks need to be carried out, to apply the appropriate looping structure to iterate over a collection of data, and to impose the necessary conditions to filter the data for display purposes. In the table below, three sections (Typical Delivery, Web Service Delivery, and Example) are presented.

In the “Typical Delivery” section, a typical approach used for discussing the topics of “Sequence, Iterative, and Decision Structures” is discussed. One example is: “Process a collection of numbers (from the user), determine which one is the largest, and finally display it.” Clearly, the sequential aspect of this is that one needs to read the input first before one can decide and then display the largest. The iterative aspect is that as each number is processed, an if/else statement is needed to keep track of the largest (so far).

In the “Web Service Delivery” section, a comparable scenario to the above is described. The idea here is to cover the same topic(s), but using Web services as the delivery mechanism. With Web services, the possibilities are endless and one can be creative in incorporating the topic(s) at hand in a way that engages the students more. For example, instead of processing a random list of numbers, the students can be processing a set of numbers representing the populations of all the 50 states via a Web service. Now, the numbers have meanings and the processing seems more interesting as it ties in with their general knowledge about the US geography/society.

Finally, in the “Example” section, a specific scenario that details how the “Web Service Delivery” section can be implemented is given. In Table 1, the example is about finding the warmest temperature in the entire U.S. by zip code, plotting the area on a map, and getting a route to go to the warmest area from a given location. The Web services that help in achieving the result are pointed out in this segment.
### Table 1: Sample module for web service approach

<table>
<thead>
<tr>
<th>Module Name:</th>
<th>Sequence, Iterative, and Decision Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Delivery:</td>
<td>These topics are typically covered by traditional discussion of scenarios that (1) necessitate a certain ordering be imposed in order to solve a problem (e.g., read the input values before processing them), (2) require a loop be used (e.g., processing a collection of numbers to find the average), and (3) need an if-else structure be employed (e.g., find the largest and smallest numbers from a collection of numbers).</td>
</tr>
<tr>
<td>Web Services Based Delivery:</td>
<td>Instead of merely processing a collection of numbers or strings that may be meaningless (and boring to the students), one could present a scenario where the goal is to solve a problem by using the three fundamental structures and some existing Web services that can be composed to form a solution for the problem.</td>
</tr>
<tr>
<td>Example:</td>
<td>A plausible scenario here is to discuss a problem where one wishes to find out the warmest temperature in all the U.S. by zip codes at a particular moment in time. Further, the warmest area of the country needs to be plotted on a map. Lastly, get a route to go to the warmest area from a given location. This scenario, which is much more interesting for today's freshmen, may seem intractable in the traditional computing environment. But there exist various publicly available Web services that can be composed together to solve this problem rather effortlessly. There exists one that retrieves all the US zip codes (Remotemethods, 2008), another one that finds the temperature given a zip code (xMethods, 2008), yet another one that plots a particular area on a map given a zip code, and one that plots the route given two endpoints (Google Maps, 2008). Thus, one can cover the sequence, iterative, and decision structures all in one shot using above example.</td>
</tr>
</tbody>
</table>

3. Evaluation of the pilot study of the web service approach

The pilot study employed a quasi-experimental design. The advantage of this design is that the control and experimental groups were comprised of real students in real classes in which real professors field-tested the teaching method. This design offered advantages in external validity (or generalizability) and ecological validity (similarity of the study setting to the settings in which it will be applied). The disadvantage was that student experimental participants could not be randomly assigned to treatment groups as they might have been, for example, in a learning laboratory experiment. Random assignment provides greater internal validity (certainty about causal attributions). The advantages in external and ecological validity more than compensate for the disadvantage in terms of internal validity. A laboratory approach would be less appropriate because it could not deliver the teaching method in a realistic fashion. The method studied in the project is designed for use in regularly scheduled classes and requires implementation over a period of several weeks. That is why field experiment used pre-existing groups of students and their instructors. The experimental group was the students of instructors who adopted the WS approach; the comparison group was students whose instructors did not use the WS approach.

The above discussed advantages of this design led to its adoption in the expansion study as well as in the pilot. However, quasi-experiments and field experiments pose special measurement problems.
Methods of measurement of outcomes appropriate for laboratory experiments (mean difference between control and experimental groups) must be supplemented in this type of design. Chiefly, this means the addition of control variables (covariates) to ensure that outcomes are not attributable to variables other than differences in treatments. To accomplish this multiple regression techniques were used to control for students’ majors, class ranks, genders, and cumulative grade point averages before treatment. These covariates were used for two reasons: (1) to establish that the control and experimental sections/groups were initially comparable at the group level (they were) and (2) to control at the individual level for variables that could confound results. The same strategy was used for both the pilot study and for the current expansion study. The main differences between the pilot and the expansion study are in the measurement of the outcomes.

In the pilot study the main outcome measure was scores on the common final examinations given in the IS and the CS courses over 4 semesters both in experimental classes and in comparison group classes. The results (described in detail elsewhere (Hosack et al., 2011)) were encouraging. Even after controlling for other variables that could explain differences among students in learning outcomes, the 222 students in the treatment group classes scored about 5 points higher (out of 100) on average than the 364 students in the comparison group classes (\( p = .03 \)). Also, considerable qualitative evidence indicated that the students in the treatment group classes found programming to be more interesting and engaging. This was enough for us to want to see whether these positive results would hold beyond a single university. We applied for and received funding from the NSF to expand our research over a period of three years to a group 24 universities. The next section describes the procedures used for evaluating results from this much larger group.

4. Framework for measuring student learning gains and engagement in the expansion study

The same quasi-experimental design is being used for the expansion study, and for the same reasons: greater external and ecological validity. And the same regression-based models are employed to assess outcomes. But on the basis of what was learned in the pilot study and because there will be a much greater number of cases, more extensive and rigorous measures of student gains in learning of and engagement with the subject matter are being employed. To better measure any learning gains that could be attributed to the new methods of instruction, a pretest and a posttest (see the documents in Appendix A) are used. These take the form of the Student Assessment of Learning Gains (SALG), which is a nationally validated pre- and post-survey of students’ self-assessment of their knowledge before and after a course. Because it has been used in numerous courses over many years it can provide the basis for measured comparisons of student learning. Instructors using the SALG can, while retaining the format, adapt the questions to their particular learning goals and add questions as needed. Students are asked about skills and their understanding of concepts at the beginning of the class and at its conclusion. For example, the questions in section 2 of the pre-survey are strictly parallel to those in section 3 of the post-survey: each set of questions asks the same skills.

The SALG questions were also used to measure student engagement, which is an important learning outcome in its own right and which, as postulated, will be an important predictor of student learning. The quality of the analysis was also improved by the addition of a new background variable: self-efficacy (questions 3.1 – 3.12 on the pre-survey). Self-efficacy has repeatedly been shown in numerous studies to account for a good deal of the variance in performance and learning in a wide range of contexts (Bandura, 2006). A final predictor variable, to be coded and analyzed by the principle investigators, is fidelity of, or intensity of, implementation of the new curriculum. It is to be expected that with dozens of faculty participants, there will be differences in the rigor with which the new curriculum is implemented and that these differences will have an important impact on the student learning and engagement variables that are the main outcomes of the study.

In addition to using the SALG assessments the researchers have designed an assessment test module of objective questions to be taken by students in both the control and experimental classes at the end of each semester. The questions measure student knowledge of programming concepts and skills. This common module of objective questions will allow comparisons across universities. The questions have been reviewed at a workshop with the first cohort of faculty participants; in the judgment of that group as well as of the principle investigators the questions have extensive face validity. The use of objective questions with a large N of student participants will enable the
researchers to use more advanced analytic techniques to measure student outcomes in the study, specifically: (1) propensity score matching to simulate experimental attribution of cause and (2) item response theory (specifically differential item functioning or DIF) to conduct subgroup analyses of responses to particular questions in the module. A final outcome measure is an instructor assessment of students’ learning as well as of the instructors’ own reactions to the new method of teaching programming. The combination of these factors yields the causal model shown in Figure 1.

The narrative in parts 3 and 4, on evaluating the pilot and the expansion study, strongly implies a causal model. To make the implied model, the causal diagram graphic is presented in Figure 1. The main independent or predictor variable is WS vs. Traditional, which are the treatment and comparison groups respectively. The thick arrow between the predictor and student engagement means that it is anticipated that WS will positively affect engagement, and student engagement, in turn will positively influence learning. This is shown by the second thick arrow, the placement of which indicates that student engagement is a mediating variable. While it is possible that the treatment could influence either student engagement or learning without having a comparable effect on the other, and this will be tested for, it is unlikely. Next, it is assumed that background variables (cumulative GPA, academic major, gender, etc.) will influence learning independent of the main line of causal variables, which is why that cluster of variables enters the model from the “outside.” The same kind of external influence on learning will probably be exerted by self-efficacy. Finally, the two measures of student learning, the SALG survey and the objective test module, are on the far right of the model; the arrows point from those measures to the variable, learning, that they measure. A line between SALG and TEST has no arrow heads because, while they will probably be correlated, there is no causal relation between them. Rather they are two indicators of the same latent variable (learning).

![Causal Diagram](image)

**Figure 1: Causal diagram**

### 5. Discussions

Based on lessons learned from an earlier pilot study, we concluded that there are three key improvements that can be made to a multi-site pedagogical study. First, using the SALG instrument to collect the student’s perceptions of gains they have or have not made under the new approach gives a more reliable assessment. Second, included in the SALG instrument, were questions on student self-efficacy and engagement. As outlined in Section 2, the approach allowed students to personally connect with the material that also had real world applications in their future academic and professional careers. Finally, we incorporate in the framework a means to manage the data collection and assessment across multiple sites as part of a longitudinal study.

SALG enable a better assessment of student learning gains while new questions on self-efficacy and engagement better capture the student’s response to the new pedagogical approach. Combining the measurement of these three areas adds to the robustness of the SALG instrument and provides some insight into the student’s perceptions of the approach. The impact from being able to see multiple facets of the student’s viewpoint is exciting. The combination of factors also allows us to triangulate a student’s perception of the approach and get a better idea of whether or not it was a success beyond measuring an improvement in grades the common question exam items across CS and IS curricula.
Pairing a strong data collection model with the appropriate pedagogical approach is equally important. The approach outlined in Section 2 in the pilot study promoted self-efficacy and engagement while improving learning both from the student’s perception and also in the quantitative data. Since, the instruments used in the pilot study did not consider all aspects of learning gains, self-efficacy and engagement, the lesson learned in finding a good match between approach and instrument can’t be stressed enough.

The causal model in Figure 1 will be applied across multiple institutions and this will provide a better means to evaluate the approach’s effectiveness across universities and different student demographics. Based on findings in the pilot study a modular approach to collecting data will be applied. The structure of the SALG instrument provides the ability to collect data on students and courses regardless of content using an online survey as a centralized collection point. Based on experience, a set of questions targeting core programming concepts has been developed. This question set can be tailored based on the concepts covered in a particular course allowing the experiment to adapt to each institution’s curriculum while applying the Web service approach. Online completion of the common programming questions again allows for centralized data collection. When evaluating multiple institutions, the framework allows for the adjustment for quarter or semester scheduling and small (possibly a single instructor and section) or large (possibly multiple instructors and multiple sections) programs. The use of the SALG instrument and modular common questions makes this possible. Thus, data collection may spread over multiple semesters with the same instructor teaching comparative sections or multiple instructors running parallel comparative sections. Finally, using control background data across institutions allow for us to ensure that we can control for variances in participant populations across institutions.

Data from the first semester of the expansion study
As of this writing we have collected data from the first semester of the expansion study. The analysis of these data is approached in the spirit of “training data,” or “statistical learning,” in which early analyses are used to improve the collection and analysis plans for subsequent data (Berk 2006; Hastie et al, 2009). We have focussed initially on the measurement properties of the variables and on planning for analysis of data from upcoming semesters. Analyses of outcomes comparing control and experimental groups are of limited value at this stage. Only 5 professors at 4 universities teaching approximately 120 students participated in the project in the first semester; and because of the fairly high dropout rate in those courses, complete data are available for only 90 of those students. The number of valid cases from the first semester is not sufficient for the analysis of outcome variables (because of inadequate statistical power), but it is fully sufficient for discussing the measurement properties of the main variables.

Variables
The study uses five types of variables:

(1) Outcome variables:
The primary outcome of interest is student learning. This is measured in two ways, which allows us to cross-validate findings—with the student assessment of learning gains (SALG) and with the content knowledge survey (CKS), which is an objective test of their knowledge. For example, students are asked on the SALG to self-report their understanding of particular concepts (see Douglas et al., 2012). Their understanding of the same concepts is tested on the CKS. Each measure helps validate the other and enhances the investigators’ ability to interpret data related to the main outcome variable—student learning.

(2) Predictor or independent variable:
The independent variable is whether student participants are in a control or experimental section.

(3) Control variables:
The background variables gender, academic major, class rank, cumulative grade point average, and student experience with programming are used as controls as is the student self-efficacy measure described above (see Zajacova, et al., 2005).

(4) Mediating variable:
The mediating variable postulated to influence the outcome in the study is student engagement (Ahlfeldt et al. [2005] and Carini et al. [2006]). This means that it is believed that WS instruction influences student learning directly and also indirectly by increasing student engagement.

(5) Additional pedagogical variables:
Also included are three categories of pedagogical variables in which students describe what was helpful in their learning of the subject matter: How much did each of the following help your learning:
(1) activities, such as participating in discussions and attending lectures, (2) assignments, such as lab work and quizzes, and (3) resources, such as textbooks and sample programs? For each of these categories students are given both a 5-option scale (ranging from no help to great help) and an open-ended question to which they can type a response. (These are questions 6.1 – 6.5, 7.1 – 7.5, and 8.1 – 8.4 on the post-SALG).

**Scale Reliabilities**
When using an existing scale, even one that has repeatedly been tested for reliability, such as the SALG, one must still conduct one’s own tests of the reliability of the scales in the study using the responses of participants in the study. Reliability is not an invariant property of scales. It always refers to and varies from one sample to the next and/or from one investigator to the next. The scale reliabilities and much other descriptive information about the scales used in this study are provided in Table 2.

### Table 2. Item scales: descriptive statistics and reliabilities

<table>
<thead>
<tr>
<th>Scale</th>
<th>Mean of Items¹</th>
<th>Alphas²</th>
<th>Scale Means(N)³</th>
<th>Std dev of Scale</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre: understanding concepts</td>
<td>2.21</td>
<td>.919/.920</td>
<td>13.28 (6)</td>
<td>5.61</td>
<td>127</td>
</tr>
<tr>
<td>Pre: programming skills</td>
<td>2.13</td>
<td>.945/.944</td>
<td>12.75 (6)</td>
<td>6.34</td>
<td>122</td>
</tr>
<tr>
<td>Pre: learning attitudes, self-efficacy</td>
<td>4.01</td>
<td>.914/.919</td>
<td>44.07 (11)</td>
<td>7.78</td>
<td>128</td>
</tr>
<tr>
<td>Post: understanding concepts</td>
<td>3.60</td>
<td>.878/.882</td>
<td>21.58 (6)</td>
<td>5.75</td>
<td>85</td>
</tr>
<tr>
<td>Post: programming skills</td>
<td>3.84</td>
<td>.835/.860</td>
<td>17.20 (5)</td>
<td>4.15</td>
<td>86</td>
</tr>
<tr>
<td>Post: learning attitudes, self-efficacy</td>
<td>3.44</td>
<td>.959/.960</td>
<td>27.54 (9)</td>
<td>8.58</td>
<td>91</td>
</tr>
<tr>
<td>Post: Student engagement in learning</td>
<td>3.09</td>
<td>.725/.688</td>
<td>30.85 (10)</td>
<td>6.09</td>
<td>81</td>
</tr>
<tr>
<td>Post: Content knowledge survey (test)</td>
<td>.589</td>
<td>.693/.676</td>
<td>11.79 (20)</td>
<td>3.43</td>
<td>89</td>
</tr>
</tbody>
</table>

**Notes:**
1. The items are on a scale of 1-5 except on the content knowledge tests where the range is 0 (incorrect) to 1 (correct).
2. Alphas are reported in the natural metric and for standardized items: natural/standardized.
3. The number in parentheses is the number of items in the scale.

The scales and the variables they measure are discussed above. Here we summarize their measurement properties and present some summary statistics. The column entitled “Alpha” presents two versions of Cronbach’s alpha, each of which indicates a very similar level of reliability or
consistency of measurement. The reliabilities for all the measures except the last two are very high. The last two—post student engagement and the CKS—are only acceptable. That is because each of those measures is almost certainly more than one scale; each tests students on several domains of subject matter or course participation. The presence of multiple domains will be tested with confirmatory factor analysis after data are gathered from a sufficiently large number of participants.

The column “mean of items,” gives the average score (on a 1 to 5 scale) given by a student in response to a self-assessment question. For example, the 2.21 in the first row, indicates that the average rating of his/her understanding of various concepts was a bit over 2—or “just a little.” Comparing that to the post understanding of concepts, 3.60, we can see that students said that on average they understand concepts on a range from “somewhat” to “a lot.” (See the Pre and Post SALG questionnaires in the appendix for the full text of the questions.)

The scale means are in essence the item means multiplied by the number of items. So, for pre understanding of concepts multiply the 2.21 times 6 items to get the scale mean of 13.28. This statistic is interesting mainly in how it relates to the standard deviations. In all cases, the standard deviations are sizeable as compared to the scale means. This indicates that there is variance sufficient for analysis in the answers the students gave to the scale questions. In sum, all the measures that are important to the analysis of data in this project are “well behaved.”

6. Summary and conclusions

We present an approach to better evaluate pedagogical approaches to teaching in the IT classroom. While our approach focuses on lessons learned from an earlier pilot study teaching introductory programming to CS and IS students using Web services, we feel this approach is easily tailored to other methods of teaching as well. The instruments proposed for use in this study can be used to target a variety of skill sets. The key lesson learned was finding a good match between the instrument, background data and the approach. Based on a relatively successful pilot study, we learned the importance of this and were able to improve and share our knowledge. Additionally, based on this lesson we developed a strategy the uses modular and flexible data collection from a variety of sources to work with multiple institutions over time. Implementation of this approach will be conducted over multiple sites and years. Based on the results we’ll receive feedback on the success of our research plan outlined here. In attempting to answer the questions “Do students using the Web service approach perform better in the common assessment exam module?” and “Do students and faculty members find the Web service approach more engaging?” across many instructors, institutions and students we have found a set of tools that are applicable not only to these questions but other pedagogical questions not only in the IT field but other disciplines as well.

We also learned several methodological lessons in the early stages of the transition from a single-campus study to an investigation involving a score of universities and professors. Based on what has been learned, the PIs have made the following adjustments.

1. Concerning collecting data from many sites. In the single-university study with the cooperation of the Registrar, it was easy to collect complete and reliable data on students’ background variables including: gender, major, class rank, and cumulative GPA. The reporting of the same data from the other universities in the expansion study has been much more difficult and sometimes impossible (largely due to interpretation of IRB regulations). The remedy, not a perfect one, will be to ask students to self-report these data on the pre-survey questionnaire. When data from official documents are available they are used and compared to student self-reports.

2. Concerning attrition. The attrition rate was fairly high from the pre-data collection at the beginning of the semester to the post data collection at the end. For most measures in the first round there were 120+ responses; in the second round about 90 completed the survey and exam. (See the specifics in Table 2.) This level of attrition (around 25%) is not uncommon in introductory programming courses. Understanding the causes of attrition is now an additional goal of the study. After several semesters of data collection, information about which students drop out and which persist should be fairly extensive.
3. Concerning scale quality. The scale quality is good for all scales and more than sufficient for measurement. More sophisticated methods, envisioned for use in this study—including structural equation modeling, item response theory, and differential item functioning—are very “case hungry.” They require a much larger N of participants. More elementary methods of analysis can be used while additional data are gathered.

4. Concerning research design. The project uses two main designs. Following the first design, a professor attends a workshop and begins teaching classes using WS/SOA methods immediately. Implementing this design requires that the professor obtain the cooperation of one or more institutional colleagues who will agree to serve as control group instructors, and that entails persuading them to have their students complete the SALG and the CKS. Such simultaneous implementation of control and experimental group classes has been rare and is likely to remain so. However, this is probably an advantage in terms of the quality of causal inferences that can be drawn from the study. The second model involves the participating instructor teaching one semester of introductory programming using his/her standard methods. In the second and third semesters (after having attended the workshop) the instructor teaches using WS/SOA methods. The first design controls for time and institutional variables, since the control and experimental sections are taught simultaneously at the same institution. But it does not control for variation among instructors. The second method also controls for institutional variables, and, in addition, it controls for variation among the instructors since each serves as his or her own control. Time is not controlled in this second, longitudinal, approach. But controlling for variation among instructors is arguably more important. In the early days of the study, based on the experiences gained from the pilot study, the PIs encouraged recruits to the study to follow the first model. While we think the first model is acceptable, we now believe that the second, within-subjects model, in which instructors serve as their own controls, is not only more practicable but also a stronger design.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant No. NSF DUE-CCLI-0837056 and TUES-1123094

References


Appendix A:

Student Assessment of Learning Gains: Pre-Survey

Instructions to students

Teachers value students’ information feedback and take it into account when improving their courses. Please be as precise as you can in your answers. Please choose “not applicable” for any activity you did not do. You may find one or more questions at the end of each section that invite an answer in your own words. Please comment candidly, bearing in mind that future students will benefit from your thoughtfulness. Remember that this is an anonymous survey: your teacher will never know what any individual student has written.

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Not at all (1)</th>
<th>Just a little (2)</th>
<th>Somewhat (3)</th>
<th>A lot (4)</th>
<th>A great deal (5)</th>
<th>Not applicable (99)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Presently I understand the computer programming concepts of …</td>
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</tr>
<tr>
<td>1.1 Objects and Classes</td>
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<tr>
<td>1.2 Arrays</td>
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<tr>
<td>1.3 Class Inheritance</td>
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<tr>
<td>1.4 File Processing</td>
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</tr>
<tr>
<td>1.5 Code Reuse</td>
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<tr>
<td>1.6 Web Services</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.7 What do you expect to understand at the end of the course that you don’t understand now? (open-ended question; students type responses)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skills</td>
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<td></td>
</tr>
<tr>
<td>2. Presently I can …</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2.1 write a computer program in a programming language to solve a computer problem</td>
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</tr>
<tr>
<td>2.2 write a computer program that involves the use of repetition (e.g., loop) statements</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2.3 write a computer program that involves the use of decision (e.g., if-else) statements</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2.4 write a computer program that involves the use of step-by-step statements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Concepts

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Not at all (1)</th>
<th>Just a little (2)</th>
<th>Somewhat (3)</th>
<th>A lot (4)</th>
<th>A great deal (5)</th>
<th>Not applicable (99)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 write a computer program that reuses existing web services</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2.6 write a computer program that involves the use of objects/classes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.7 What do you expect to be able to do at the end of the course that you cannot do now? <em>(open-ended question; students type responses)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Attitudes

3. Presently I . . .

<table>
<thead>
<tr>
<th>Attitudes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 am enthusiastic about the subject of the course</td>
<td></td>
</tr>
<tr>
<td>3.2 am interested in discussing the subject area with friends or family</td>
<td></td>
</tr>
<tr>
<td>3.3 am interested in taking or planning to take additional classes in this subject</td>
<td></td>
</tr>
<tr>
<td>3.4 have expectations for learning about programming that are positive</td>
<td></td>
</tr>
<tr>
<td>3.5 am confident that I can regularly attend this course's classes</td>
<td></td>
</tr>
<tr>
<td>3.6 am confident that I can regularly attend this course's labs</td>
<td></td>
</tr>
<tr>
<td>3.7 am confident that I can get myself to study programming</td>
<td></td>
</tr>
<tr>
<td>3.8 am confident that I can ask for help if I have programming problems</td>
<td></td>
</tr>
<tr>
<td>3.9 am confident that I can learn to understand programming concepts</td>
<td></td>
</tr>
<tr>
<td>3.10 am confident that I can learn to write computer programs</td>
<td></td>
</tr>
<tr>
<td>3.11 am confident that I can learn to solve computer programming problems</td>
<td></td>
</tr>
<tr>
<td>3.12 Please comment on your present level of interest in the subject of this course and your confidence that you can succeed in it. <em>(open-ended question; students type responses)</em></td>
<td></td>
</tr>
</tbody>
</table>

### Experience

<table>
<thead>
<tr>
<th>Experience</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 How long have you used a computer to surf the Web, word process, make presentations, etc.?</td>
<td></td>
</tr>
<tr>
<td>4.2 If you have programmed before, how long have you done so?</td>
<td></td>
</tr>
<tr>
<td>4.3 What is your class rank? <em>(check the appropriate box)</em></td>
<td>Freshman</td>
</tr>
<tr>
<td>4.4 How old were you on your last birthday? <em>(please write in the number)</em></td>
<td></td>
</tr>
<tr>
<td>4.5 What is your academic major? <em>(please type in response)</em></td>
<td></td>
</tr>
<tr>
<td>4.6 Are you Female or Male? <em>(please check the appropriate box)</em></td>
<td>Female</td>
</tr>
<tr>
<td>4.7 What was your college grade point average before taking this course? <em>(please type in the number; if you do not know it exactly, please estimate)</em></td>
<td></td>
</tr>
</tbody>
</table>

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Student Assessment of Learning Gains: Post-Survey

Instructions to students

Teachers value students’ information feedback and take it into account when improving their courses. Please be as precise as you can in your answers. Please choose “not applicable” for any activity you did not do. You may find one or more questions at the end of each section that invite an answer in your own words. Please comment candidly, bearing in mind that future students will benefit from your thoughtfulness. Remember that this is an anonymous survey: your teacher will never know what any individual student has written.

<table>
<thead>
<tr>
<th>1. Your Activities for this Class: During this class and in your preparations for it, how often did you do each of the following?</th>
<th>Never (1)</th>
<th>Once or twice (2)</th>
<th>Sometimes (3)</th>
<th>Often (4)</th>
<th>Very Often (5)</th>
<th>Not applicable (99)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Worked with other students outside of class to prepare assignments</td>
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<td>1.2 Asked questions in class or contributed to class discussions</td>
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<td>1.3 Missed class</td>
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<tr>
<td>1.4 Attended class without having prepared</td>
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<td>1.5 Attended the weekly labs and did the assignments</td>
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<td>1.6 Discussed course content with the instructor</td>
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<td>1.7 Discussed course content with other students in the class</td>
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<td>1.8 Discussed course content with people not taking the class (friends, co-workers, etc.)</td>
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<td>1.9 Became engaged in class assignments because they could be applied to real problems</td>
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<td>1.10 Applied what you learned to topics of interest to you outside of class</td>
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<table>
<thead>
<tr>
<th>Your understanding of class content</th>
<th>No gains (1)</th>
<th>A little gain (2)</th>
<th>Moderate gain (3)</th>
<th>Good gain (4)</th>
<th>Great gain (5)</th>
<th>Not applicable (99)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. As a result of your work in this class, what GAINS DID YOU MAKE in your UNDERSTANDING of each of the following?</td>
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<tr>
<td>2.1 Objects and Classes</td>
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<td>2.2 Arrays</td>
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<td>2.3 Class Inheritance</td>
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<td>2.4 File Processing</td>
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<td>2.5 Code Reuse</td>
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<td>2.6 Web Services</td>
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