Editorial for EJEL Volume 13 Issue 5

Coming soon
Abstract: In 2013, Facebook was used in learning and teaching clinical problem solving in a Pathology and a Clinical Sciences course delivered at a South Australian university. It involved first- and second-year Medical Radiation students and second-year Nursing students. Of the 152 students enrolled in the Pathology course, there were 148 students who participated in the Facebook group. Of the 148 students, 61 (41%) completed the invited post-intervention questionnaire. At the same time, all 17 nursing students enrolled in a science course at the regional campus of the same university participated in the Facebook initiative, however, only 10 (59%) completed the post-intervention questionnaire. A good practice and checklist were developed from the post-intervention evaluations, which consisted of 25 Likert- and open-type questions. Both student cohorts found the use of Facebook beneficial for them in terms of providing an innovative way of learning; fostering greater interaction amongst co-students and staff; and effectively engaging them with the content of courses. The importance of clear communication of goals and objectives to students was identified from student comments. Six good practice principles were identified relating to: goals and objectives, expectations, communication, engagement with the course content, active participation, and learning environment.

Keywords: Facebook, social media, medical radiation, nursing, guidelines for good practice, engagement

1 Introduction

In the age of internet, social interaction and engagement has evolved. Social media has become an integral avenue of social interaction. Given that engagement with peers is an important component to student success in higher education (Thalluri, O’Flaherty, & Shepherd, 2014), Contemporary teaching methods have been adapted to include social media, specifically the Facebook, a very popular networking website amongst all age groups. In order to maximise the potential of Facebook for collaboration and interactivity, various universities have attempted to incorporate it in their learning and teaching approaches. Medicine, pharmacy, medical radiation, veterinary students and library users have reported using Facebook (Thalluri & Penman 2014; Black et al. 2010; Hendrix et al. 2009; Cain 2008; Thompson et al. 2008). Undergraduate students are deeply immersed in this social network; for example, in the United States, over 90% of undergraduate students participate in Facebook (Ellison et al. 2007; Stutzman 2006).

The real and potential benefits of Facebook are documented. It presents a relaxed, accessible, friendly and comfortable environment that promotes collaboration, social exchange of knowledge/ideas, and student engagement in learning outside the classroom. Whittaker, Howarth and Lymn (2013) posit that technologies used in learning promote a social constructivist educational approach which is student focused, highlighting open dialogue and collaborative construction of knowledge. There is also collegial support and enhanced networking opportunities (Wodzicki, Schwammlein & Moskaliuk 2012; Bosch 2009). Together this represents many of the skills and supports that are necessary for positive engagement and continued learning beyond the university degree into the professional career. In this way, social media may be key to modern professional engagement and continued learning.

On the other hand, the educational value of Facebook may be questioned. For instance, Hew (2011) in reviewing current published research studies on the use of Facebook by students and teachers concluded that there is very little educational value and that its application is limited to staying connected with others. Wise, Skues and Williams (2011) corroborate this view, stating that Facebook promotes social but not academic engagement. Further, this new digital paradigm is changing how we relate to society (Madden 2013). In the midst of proliferating social connected devices and websites, there are feelings of isolation and loneliness. It
looks like an “illusion of companionship without the demands of relationship” (Madden 2013, p. 13). This concern has merit, but may be mitigated by attention to maintaining Facebook and other social media as an adjunct to more meaningful social/academic interactions such as meeting in person for lectures, tutorials, practicals, and group study sessions. To this end, several authors have already argued.

The need to provide guidelines for its use (Ponce et al. 2013; Black et al. 2010; Gray, Annabell, & Kennedy 2010; Cain 2008; Thompson et al. 2008). University students are already using the platform as it is accessible, quick and convenient, and there is a real potential for its application on learning and teaching provided that it is carefully and appropriately structured.

This paper reports on an investigation into the success of Facebook as an educational tool for a Pathology course for Medical Radiation students and a Clinical Sciences course for Nursing students. The focus is on the development of good practice principles relating to learning and teaching utilising Facebook groups. This is important because learning and teaching in Facebook is not the same as classroom teaching; all the forces at work are different. In this intervention Facebook was used as a means of studying particular topics, contracting knowledge, signposting relevant resources, solving problems and/orreflecting on understanding and practice. The rationale behind the development of these post-intervention evaluations include: to inform and guide academics how to effectively use social media to enhance the learning and teaching of science concepts to undergraduate students, to provide them with key principles specifically related to Facebook learning and teaching, to assist in developing effective Facebook learning and teaching resources, and to ensure high quality learning and teaching of sciences using social media and high quality and satisfying academic experience for students.

2 Methodology

The service offered by Facebook Inc. was used as a platform for a Pathology class (identified as a common-interest user group), divided into groups in order to decipher case scenarios (Penman & Thalluri 2013; Thalluri & Penman 2013). Six pre-determined real-life case scenarios with problems and corollary questions were distributed to students who grouped themselves and divided the work to address the requirements of the scenarios. A case typically reported on a client presenting to the hospital with various medical complaints. The present illness, past medical history, family history, investigations, and treatments completed the case. Students used the approach to solve the general problems of: explaining disease processes of medical conditions, conducting and interpreting diagnostic procedures and rationalising the medical interventions undertaken. The lecturer/s posted the real-life case scenarios on Facebook for groups to access and discuss online. The culmination of the group process was a student-created product in the form of PowerPoint presentations and short videos clips which were to be presented to the lecturers, tutors and entire class, and made available on Facebook. The same procedure was undertaken for the Clinical Sciences course for nursing students, using case scenarios with similar content; the difference was emphasis on nursing interventions rather than clinical investigations and radiological medical interventions.

Prior to the Facebook activity, approval for the initiative was obtained from the university’s ethics committee. Information letters were sent informing students about the initiative and inviting them to participate in the study being undertaken, the aims of which were to understand the impact of the use of Facebook on the learning and teaching of science concepts in the undergraduate Medical Radiation and Nursing programs and to determine the perceptions about the use of this medium. Assurances of confidentiality of information and the voluntary nature of involvement were given. The lecturers/administrators organised the groups to enhance interaction and facilitate support for students, allowing for both synchronous and asynchronous electronic communications.

Evaluation of the learning that transpired using Facebook was conducted at the conclusion of the course using a post-intervention questionnaire administered via web-based TellUs2. A Likert- and open type questionnaire was used to cover various aspects such as: 1) the flexibility of Facebook; 2) opportunities to learn with peers; 3) opportunity to work with others; 4) opportunity to direct own learning of topics; 5) development of learn life-long learning skills; 6) engagement with content of the course; 7) learning opportunities; 8) increase interest on subject matter; 9) ability to synthesise past and present knowledge; 10) honing of research skills; 11) adequate introduction; 12) acceptable duration; 13) assisted in learning of the topic; 14) provided opportunities to interact with the lecturer; 15) opportunities to collaborate with peers; 16) pleasant learning
experience; 17) substitute for classroom; 18) effective way to learn; 19) innovative; 20) understanding of disease processes; 21) recommend to other students; 22) best things in the use of Facebook; 23) areas for improvement; 24) most important outcome; and 25) additional comments.

3 Results

Of the 152 students enrolled in the Pathology course in 2013, there were 148 students who participated in the Facebook activity. Of the 148 students, 62 opened the survey but only 61 completed the post-intervention questionnaire, representing a 41% response rate. The majority of the students rated the use of Facebook positively in the pre-defined categories. Of the 17 nursing students enrolled in the science course at the university’s regional campus, all participated in the Facebook group. Of those, 10 completed the post-intervention questionnaire representing 59% response rate. (Note that regional campus enrolments are smaller by comparison to the university’s main campus enrolments, explaining the significant difference in sample sizes.)

Post-intervention results reveal positive perceptions about the application of Facebook in the Pathology course. Students reported that Facebook gave them flexibility in their learning (they recommend this initiative to other students (92% and 100% of Medical Radiation and Nursing students respectively responded that they strongly agree or agree). Most agreed that Facebook provided them with opportunities to learn with peers (92%; 100%) and work with others (87%; 100%), as well as the opportunity to direct their own learning (81%; 80%). Many considered the Facebook initiative to facilitate the development of lifelong learning skills (58%; 80%). They engaged well with the course content (68%; 80%). Many attested that there were many opportunities in learning this medium of learning and teaching (66%; 100%). The initiative increased students’ interest in the subject (66%; 100%). Students had mixed opinions on whether the initiative allowed them to synthesise past and present knowledge (76%; 30%), or honed their research skills (48%; 60%). They did feel the initiative was adequately introduced (95%; 80%) and that the duration of attention required was acceptable (92%; 100%). Most asserted that the initiative their learning about the topics (87%; 90%). Students agreed that they were provided with opportunities to interact with the lecturer (97%; 100%) and learn from peers (95%; 90%). They considered it a pleasant learning experience (90%; 80%) but were of mixed opinions on whether it made a good substitute for classroom learning (53%; 40%). Regardless they found it an effective (79%; 80%) and innovative (87%; 80%) way to learn. Most found that the initiative enhanced their understanding of disease processes (73%; 80%), and would recommend it to other students (89%; 100%). See Figures 1 and 2 summarising the perceptions of students about the Facebook activity.

![Figure 1](https://www.ejel.org/457/ISSN_1479-439X.png)

**Figure 1:** Likert survey of medical radiation students’ perceptions about Facebook after completing the course. n = 62.
The following tables, Table 1 and 2, summarise the responses to the open questions. Students’ diverse responses were grouped into categories, counted and tabulated.

Figure 2: Likert survey of nursing students’ perceptions about Facebook after completing the course. n = 10.

Table 1: Post-intervention responses for open questions (Perceptions about Facebook after Pathology course) n=62

<table>
<thead>
<tr>
<th>Open questions</th>
<th>Response</th>
<th>N*</th>
</tr>
</thead>
<tbody>
<tr>
<td>The best things about the use of Facebook are:</td>
<td>Ease of access, quick and easy to use, convenient</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Extra resources</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Interaction with lecturers and students</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Familiarity</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Response to questions</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>No answer</td>
<td>18</td>
</tr>
<tr>
<td>Some things that I think would improve future offerings are:</td>
<td>Post more questions</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Provide explanation to answers</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Posting more additional readings and resources</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>No answer</td>
<td>42</td>
</tr>
<tr>
<td>What was the most important outcome gained from this initiative?</td>
<td>Knowledge and understanding</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Friendly learning environment</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Collaborative learning with peers</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Engagement</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Easy access</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Interaction/communication to lecturers and peers</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No answer</td>
<td>30</td>
</tr>
<tr>
<td>Additional comments</td>
<td>Positive comments</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Negative comments</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>No answer</td>
<td>50</td>
</tr>
</tbody>
</table>

*Number of times the item was identified
Table 2: Post-intervention responses for open questions (Perceptions about Facebook after Clinical Science course) n=10

<table>
<thead>
<tr>
<th>Open questions</th>
<th>Response</th>
<th>N*</th>
</tr>
</thead>
<tbody>
<tr>
<td>The best things about the use of Facebook are:</td>
<td>Interaction/quick replies with peers and lecturer</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Gives students the opportunity to learn from each other and discuss uni</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>related issues</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instant feedback</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Continuation of learning outside of classroom time</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Easily accessible</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Able to share and access information freely</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>It gives a glimpse of how and what other peers are thinking.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group study could be achieved</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some things that I think would improve future offerings are:</td>
<td>Having a Facebook learning page for each course</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Clarify more fully the use of this program</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>No answer</td>
<td>8</td>
</tr>
<tr>
<td>What was the most important outcome gained from this</td>
<td>Closer relationship with lecturer</td>
<td>3</td>
</tr>
<tr>
<td>initiative?</td>
<td>Communication with classmates</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Instant feedback on all questions about the course or other subjects from</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>the lecturer and peers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extra information from lecturer</td>
<td></td>
</tr>
<tr>
<td>Additional comments</td>
<td>Positive comments</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Negative comment</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>No answer</td>
<td>6</td>
</tr>
</tbody>
</table>

*Number of times the item was identified

4 Discussion

The use of Facebook as a platform for a group learning activity for the majority of students in this initiative. Facebook assisted students’ learning about the topics (87%; 90%), helped them direct their own learning (81%; 80%), and enhanced their understanding of disease processes (73%; 80%). Most students maintained that Facebook was an innovative (87%; 80%) and effective way to learn (79%; 80%). The Facebook activity provided students with a pleasant learning experience (90%; 80%) and flexibility in their learning (92%; 100%). In this way, Facebook appears to be an education tool that is well suited to the modern students’ dynamic learning style(s).

Student engagement is a strong contributor to student success in higher education but is difficult to facilitate and promote. Student engagement includes that with course content, with lecturer(s), and with peers. The current trend for mass higher education has resulted in very large cohort sizes and the opportunity to interact directly with lecturers has become minimal despite open door policies. Also, large groups are correlated with a decrease in interpersonal interaction, such that forming a group of peers for friendship and learning becomes more difficult. More direct opportunities for interaction with peers would be beneficial. In this study, students reported that Facebook facilitated their engagement with the course content (68% and 80% for the Medical Radiation and Nursing students, respectively).

Moreover, it increased students’ interest in the subject (66%; 100%), provided opportunities for greater interaction with the lecturer (97%; 100%), facilitated learning with peers (92%; 100%), learning from peers (95%; 90%), and working with others (87%; 100%). Furthermore, while the graded group activity was concluded the Facebook group and Facebook ‘friends’ remained. These peers had the opportunity to further their friendships and professional learning collaborations in the future. From this it appears that Facebook could become an integral part of a rounded, engaging, and lasting experience in higher education.

Approximately half of the Medical Radiation students and a minority of the Nursing students were of the opinion that Facebook could be a good substitute for classroom learning (53%; 40%). In actuality, Facebook cannot substitute for face-to-face learning and teaching; it was applied here as an additional tool to enhance the core modes learning and teaching that are lectures, tutorials and practicals.
Nursing students expressed a poor positive response (30%) for the statement querying the effect of Facebook on synthesising past and present knowledge, while the Medical Radiation students’ response was positive. The Nursing students did not do research or synthesise past and present knowledge while on Facebook in real time, but if they engaged actively in the initiative in the way it was designed, they would have undertaken research and connected with their past and present knowledge. It is interesting to note that while the majority of students reported increased engagement (68% and 80%) and interest (66% and 100%) in the subject, this did not necessarily translate to increased initiative for research and learning. A possible explanation can be discerned from the Medical Radiation students’ report that the initiative did not contribute considerably to honing their research skills (48%). When combined with the finding that students were appreciative of an adequate introduction to how Facebook would be used (95%; 80%), it appears that attention should be given to introducing tools and methods for research and learning that students can use both independently and as a part of group learning in their own time away from classes. Again, the trend for mass education has brought an increasingly diverse cohort to higher education, so such skills should no longer be assumed. Proficiency in research and learning skills would increase the likelihood of effective and active engagement in Facebook activities and many other areas of higher education.

This study indicated overwhelmingly that using Facebook offered many benefits and advantages for students. In providing an interesting, interactive, gratifying and productive way of learning and teaching via Facebook, students could be assisted to be successful learners (Irwin et al. 2012; Ferdig 2007). Good practice guidelines may be drawn from this study when one considers the features of the Facebook initiative that appealed and worked well for both cohorts of students. Six good practice principles for academics, namely 1) defines goals and objectives, 2) clarifies expectations, 3) facilitates communication with co-learners and staff, 4) engages students with the course content, 5) encourages active participation, and 6) provides a conducive and safe learning environment. Earlier pieces of work by Chickering and Ehrmann (1996) and Chickering and Gamson (1987) on good practices on teaching utilising technological advances have relevance on this Facebook good practice guidelines.

4.1 Good practice defines goals and objectives

Objectives to be achieved in utilising Facebook include: to enhance learning and teaching experience of students, increase communication and interaction, promote student-student/student-teacher engagement, get to know other students and the lecturer on a more personal level, stay connected, reduce student disengagement, guide students and new staff, and ensure quality delivery of course. These goals were evident to the administrators of the initiative and the survey assessment, but appeared unclear to participating students, as seen by a nursing student’s suggestion to:

Clarity more fully the use of this program [Facebook] to enhance the communications between students to ensure their understanding and progress.

The students’ statements emphasise the need to communicate the goals and objectives at the very outset for optimal use of Facebook in higher education.

4.2 Good practice clarifies expectations

The majority of students were appreciative of the meticulous organisation of the Facebook activities which they considered to include adequate introduction (95%; 80%). The extent and duration of involvement as well as the expectations from each student participant were made clear. Students needed to know exactly what is their involvement, what is expected of them, what is required in terms of time and participation, and the knowledge and skills to be gained and used to optimise the use of Facebook as a learning and teaching tool. The lecturer/s expectations and what might be expected of them are important as well as these would indicate to students how they might succeed in this aspect of the course. It was important also to recognise that students may be unfamiliar in the use of Facebook as a learning and teaching environment. Some students may struggle with inadequate hardware/software, slow internet connections, and/or lack the technology know-how (Keengwe & Kidd 2010). This was not a major concern since the majority of students were internal so wireless internet, computers and a data allowance were readily available to them on campus. Care was taken to introduce the procedural aspects so students felt comfortable with the new learning format.
The need to elucidate the expectations is illustrated in this sentiment from a student:

*Facebook is distracting. ... I don't like Facebook as a medium for learning."* (This student explained how it led to visiting her Facebook account and being distracted from the task at hand.)

On the hand, a Nursing student remarked:

*I am not an avid user of Facebook. However, this experience has been a positive experience and has encouraged me to use Facebook as a learning tool, and a tool to further my involvement with groups associated with nursing.*

Possible distraction is a valid concern for some participants and cannot be separated from using Facebook as a learning platform. However, the efficacy of Facebook learning in facilitating student engagement is an important outcome that is increasingly difficult to promote elsewhere (tutorials etcetera), and as such the benefits of Facebook as a learning platform outweigh any potential diversion.

### 4.3 Good practice facilitates communication with co-learners and staff

Greater communication with peers and staff was one of the desirable outcomes students reported in participating in the Facebook initiative. The activity facilitated this communication by allowing students to work and collaborate, contribute to the discussion, and affirm or challenge each other’s understanding. The “presence” of the staff member/s was equally important (Penman & Ellis 2012). The best online academics are those who are actively present at the course site multiple times a week or even daily (Boettcher 2012). Interactions with students and staff do not happen only in the university but extend beyond the university.

The Medical Radiation and Nursing students attested:

*It really allowed students to engage with each other in a friendly online environment and the immediate response from the lecturers was good.*

*Collaborative learning with peers, sharing information between teaching staff and students are important outcomes.*

*There was better and faster interaction between the students and the lecturers. There was open communication and connection too.*

*Using Facebook for me was excellent as I live away and travel to campus, so this was a quicker way to keep in contact and gain info from other peers and the lecturer.*

### 4.4 Good practice engages students with the course content

The interactions centred mostly on the case scenarios and these allowed the formation of a learning community where participants were connected and fully engaged with the topics. At the same, there were meaningful and enriching activities (e.g. the quizzes, multiple choice questions You Tube clips, online resources, other extra information and updates) supplied by the lecturer/s and peers from time to time. These value-adding materials contributed in increasing interest, better understanding, and closer engagement with the course content. Knowledge was conveniently and easily accessed.

Following are comments from the students:

*The questions and extra resources helped tie things together and gain more understanding.*

*It kept me thinking about pathology.*

*Improved my learning and made me engage in this subject.*

*... helped to keep me engaged in my learning rather than just putting it aside after the lecture or workshop.*

*Enhancing learning and enthusiasm for Pathology*

*... sharing resources with peers and communicating with them. Being immediately notified of updates e.g. by mobile.*

After the students’ case presentations, students who presented posted photographs of the presentation and also tips on what worked and what did not work for them on their experiences of preparing the case
presentations on the Facebook. These assisted other groups while they prepare their presentations. This not only assisted peer to peer learning, but also allowed learning from other students’ mistakes and promoted reflection and consolidation of the new learning process.

4.5 Good practice encourages active participation

The Facebook initiative required the participants to be active in their learning and take responsibility of the same. The focus was on what students will do to meet the requirements of the case scenario assignment. Active participation meant working closely with the group members for a purpose, brainstorming ideas, searching literature to find the answers, debating, problem-solving, finding alternatives, critical thinking, and reflecting on decisions made. Threaded discussion is an excellent strategy to promote critical thinking (Ehrmann n.d.), and so with other meta-cognitive tasks as goal setting, self-monitoring and evaluation (Online Teaching in Learnonline 2010). After the groups delivered their presentations, other students were expected to peruse their work and more discussions would be undertaken. The entire class would be actively involved in deciphering the cases which maximised learning. The dynamic written format allows both real time and delayed responses, which is beneficial for shy, reticent or ESL students who find it hard to contribute in real time face to face activities such as tutorials. In this way, Facebook group activities promote active participation from a wider range of students than traditional group activities in higher education.

In using Facebook to learn about a clinical case, Pathology and Nursing students revealed:

- Accessing course information so easily and being able to ask questions as well as read answers to questions other students have asked was awesome.
- I have Facebook on my phone so it was super easy to access all the time.
- On Facebook it’s easier to use than the uni website, quick and easy to get extra information.
- We could know what was happening with the course any time as students may frequent Facebook more often than the Moodle site. Additionally, students were able to ask questions any time and get immediate response from peers or lecturers.
- The multiple choice questions posted every week and also the lecturer provides feedback on the right and wrong answers. You can also interact with the teacher.
- Good medium to discuss past exam questions.

Active participation was also illustrated in comments such as “Group study could be achieved [in Facebook].” and “Most useful for the group presentation.” as students endeavoured to contribute their bit in solving the problems required in the case scenarios. The student comments reveal that group engagement had burgeoned beyond the set group activity to include more general achievement and opportunity to prepare for the final examination for the course. This is an ideal outcome beyond the expectations of the initiative.

4.6 Good practice provides a conducive and safe learning environment

The Online Teaching in Learnonline (2010), Learning and Teaching Unit Academic Development of the university provides additional information and examples of good practice in online learning and teaching which are applicable to the creation of Facebook learning groups. Facebook staff members do not simply set a group, provide the case scenarios, and retreat waiting for students to take control. They support the learning activity actively; they help the students understand what is required and assist students to work toward the course learning objectives. Staff need to develop their communication skills to keep students interested and engaged. Their role demands that they attend to pedagogical, managerial, social facilitative and technical support aspects of the online initiative. Under pedagogical roles, Facebook staff members facilitate educational processes for students’ understanding of critical science concepts and principles, while managerial roles would include the organisational, procedural, and administrative tasks associated with Facebook as a learning environment. The technical roles refer to making the students comfortable with the system, referring students to technical support resources, and addressing technical concerns.

Equally important is the psychosocial component of Facebook teaching, promoting a friendly, pleasant and safe environment and eliciting feelings of support for the cognitive learning processes of participants. “Such social functions include developing harmony, group cohesiveness, and collective identity. Online social roles require instructors to develop nurturing skills by encouraging participation, giving ample feedback and reward,
attending to individual concerns, and using a friendly, personal tone.” (Online Teaching in Learnonline 2010). Students stressed the importance of psychosocial factors such as:

- A friendly online environment
- ... ability to ask questions in a non-confrontational manner
- Getting to know medical radiation students and lecturers
- Closer relationship with lecturer
- ... collaboration and cooperation between students

These emotions, feelings, attitudes and values have a place in effective learning (Penman & Ellis 2012; Kolb & Kolb 2005). Koballa (2011) refers to this as creating a “hospitable place for learning”. In order to achieve this ideal environment for learning, some rules of engagement or rules of conduct, also known as Facebook etiquette, is in order. Specifically, behaviours such as “putting down” a peer, using inappropriate language or visual, or posting irrelevant and inappropriate message, are not acceptable.

5 Checklist for the use of Facebook

The six principles outlined above are translated into a 16-item checklist that might inform and guide academics how to effectively use social media to enhance the learning and teaching of science concepts to undergraduate students, to assist in developing effective Facebook learning and teaching resources, and to ensure high quality learning and teaching of sciences using social media.

CHECKLIST FOR THE USE FACEBOOK FOR LEARNING AND TEACHING

- Bear in mind that Facebook is used as an additional learning and teaching tool. Involvement in the Facebook group is not compulsory, it is optional. Students may choose to use the university discussion board and/or Facebook group.

- Organise the Facebook methodically by creating a ‘Closed group’ before the start of the study period. Invite teaching and other relevant staff members to the closed group. (A closed Facebook group means only group members can see who are in it and can read the postings contributed by the members).

  1) Set clear goals and objectives to be achieved in utilising Facebook, emphasising engagement with course content, peers and staff.

- Privacy of users must be respected. Instruct students to set their privacy settings as appropriate from their end. Students have a choice of creating a new Facebook account or they can use an existing account with the appropriate privacy settings.

- Clarify expectations with students, level and duration of involvement. Encourage high level of participation.

- Provide adequate introduction. Explain how and why Facebook is being used as an educational tool. Discuss the benefits from the literature as well as from previous years’ evaluation data.

- Consider the educational, technical and administrative aspects as well as the psychosocial aspect when using Facebook.

- Allow adequate students opportunities to interact, communicate and collaborate.

- Resource sharing such as You Tube, online links, articles etc. is encouraged. However, if the material is not relevant to the course, it will be deleted by the administrators.

- Promote student-teacher interaction by providing prompt feedback, engaging discussions, and enriching and meaningful activities.

- Encourage active learning and provide opportunities for students to show evidence of their learning.

- Note the teacher’s Facebook ‘presence’ is important.
Make sure to provide a pleasant experience. Observe Facebook etiquette. Note that inappropriate postings will be deleted by the administrators.

Use a variety of teaching approaches to suit varying learning backgrounds and learning styles.

Provide opportunities for students to clarify their issues and concerns regarding assessments, final exam, class standing and other academic issues.

Evaluate the Facebook activity and determine how to continue improving its application in higher education.

6 Conclusion

This study asserts that there is merit in the use of Facebook as an adjunct in the learning and teaching of science concepts and principles. In fact, a Nursing student suggested to “[Have] a Facebook learning page for each course” of the program, while three Medical Radiation students offered: “Definitely keep this initiative going!”, “A valuable initiative, please do keep it in place for future students to benefit.”; and “It’s a good program and best to continue.” In order to ensure that goals and objectives are met and that high-quality course is delivered, good practice guidelines and a checklist for good practice were formulated. These were informed from the post-intervention evaluations administered to students which considered the features of the Facebook that were satisfactory and less satisfactory for the students.

The outcome of a well-maintained and structured Facebook group is the formation of a learning community, where participants are connected and fully engaged with content, co-students and staff, and where knowledge is conveniently and easily accessed. This represents a relatively easily incorporated way to facilitate and encourage student engagement in contemporary higher education. The good practice guidelines and checklist presented in this paper will guide academics how to effectively use social media to enhance the learning and teaching of science concepts to undergraduate students, and help provide high quality and satisfying academic experience for students thereby contributing to academic success and ongoing professional development.

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Synthesizing Technology Adoption and Learners’ Approaches Towards Active Learning in Higher Education

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Abstract: In understanding how active and blended learning approaches with learning technologies engagement in undergraduate education, current research models tend to undermine the effect of learners’ variations, particularly regarding their styles and approaches to learning, on intention and use of learning technologies. This study contributes to further examine a working model for learning outcomes in higher education with the Unified Theory of Acceptance and Use of Technology (UTAUT) on SRS adoption attitude, and the Study Process Questionnaire (SPQ) on students’ approach to learning. Adopting a cross-sectional observational design, the current study featured an online survey incorporating items UTAUT and SPQ. The survey was administered to 1627 undergraduate students at a large comprehensive university in Hong Kong. Relationships between SRS adoption attitude, learning approaches, and learning outcomes in higher-order thinking & learning and collaborative learning were analyzed with a structural equation model (SEM). A total of 3 latent factors, including four factors from UTAUT in Performance Expectancy, Effort Expectancy, and Deep Learning Approach from the SPQ, were identified in the structural model on students’ intention to adopt SRS in classes. Current results suggested that a model of active learning outcomes comprising both UTAUT constructs and deep learning approach. Model presented in the present study supported the UTAUT in predicting both behavioral intention and in adopting SRS in large classes of undergraduate education. Specifically, positive attitudes towards SRS use measured with the UTAUT, via a learning approach towards deep learning, accounted for variation on high-impact learning including higher-order thinking and collaborative learning. Results demonstrated that the process of technology adoption should be conceptualized in conjunction with learners’ diversity for explaining variation in adoption of technologies in the higher education context.

Keywords: Technology adoption; Learning Approaches; Students Response System (SRS); Higher Education

1 Background

Prevailing ideologies in higher education are advocating student-oriented, constructivist, and collaborative learning among students and their faculties (Al-Huneidi and Schreurs, 2013, Slavich and Zimbardo, 2012), in which learners must assume an active role in constructing knowledge in a collaborative and interactive learning environment. Active and blended learning approaches with learning technologies have been identified as instrumental in engaging large classes at the undergraduate level in higher education (Kerr, 2011, Exeter et al., 2010). Current research has proposed various models for outlining the process in which learners adopted such learning technologies (Venkatesh and Bala, 2008, King and He, 2006, Davis et al., 1989) and enhance their learning experience and performance.

While giving feedback individually to students in large classes remains a daunting task with limited time in face-to-face lecture, the use of SRS allows mass, yet personalized feedback to students in the face-to-face learning process with aid from adopting the blended learning approach. The use of students’ response system (SRS) with mobile devices has been demonstrated as an effective tool for engaging students in active learning under the large-class context in higher education (Velasco and Çavdar, 2013, Chan et al., 2013, Cobb et al., 2010, Shapiro, 2009, Caldwell, 2007, Schell et al., 2013).

Use of SRS for blended learning is influenced by the learner’s propensity to adopt and use the technology in their learning practices. One of the more recent and prevailing models for understanding use of learning technology is the Unified Theory of Acceptance and Use of Technology (UTAUT), a comprehensive (Venkatesh
et al., 2003) and cross-cultural (Lidia et al., 2007) model for understanding factors to behavioral intentions and actual use of technology. Core components in the UTAUT include expectancies towards performance from adopting the technology, effort required in adopting the technology, social influence to adopt the technology, facilitating conditions for adopting the technology. These core components are hypothesized to influence satisfaction and behavioral intention to continue use of the targeted technology.

However, these current models, when applied in an educational context, tend to undermine the effect of learners’ variations, particularly regarding their styles and approaches to learning, on intention and use of learning technologies. To accommodate the moderating effect of learners’ approaches, a multi-dimensional model is proposed for delineating the relationships between attitude towards learning technologies, learners’ approaches to learning, and behavioral intention towards continuous use of learning technology as one of the strategies for practicing active learning.

Recent research suggested that behavioral changes with SRS in classes influenced students’ approaches or styles to learning (Tlhoaele et al., 2015, Wang et al., 2012) towards deep approach to understanding of subject matters. Whether such deep learning stimulated by SRS in higher education would translate into learning outcomes calls for a theoretical integration and an empirical investigation.

In this context, this study contributes to further examine a working model for students’ learning engagement with behavioral intention towards SRS usage with the Unified Theory of Acceptance and Use of Technology (UTAUT) (Dwivedi et al., 2011, Lidia et al., 2007, Venkatesh et al., 2003), and the Revised Two-Factor Study Process Questionnaire (SPQ) (Justicia et al., 2008, Biggs et al., 2001) on students’ approach to learning.

The present study is set to address the research question of whether students with high readiness towards use of Clickers towards active learning (UTAUT) would be more likely to adopt deep learning approach (R-SPQ-2F) and subsequent learners’ engagement in higher order thinking and collaborative learning (NSSE).

2 Methods

This study features a cross-section observational study at a large comprehensive university in Hong Kong. An online survey incorporating items UTAUT and SPQ was administered to 1623 undergraduate students.

Participants in this study were enrolled in undergraduate courses using students response system (SRS, a.k.a. Clickers) for active learning activities in classes. Details on Clickers administration in the participating courses were reported in a previous paper by the research team (Chan et al., 2013).

Implementation of SRS in the current study was evaluated with an online quantitative instrument on various aspects of SRS implementation with 5-point Likert-type and non-Likert type questions.

- **Instruments**
- **Unified Theory of Use and Acceptance of Technology (UTAUT)**

The Unified Theory of Acceptance and Use of Technology (UTAUT) augments the original technology acceptance model (Davis et al., 1989) with addition of social influence and facilitating conditions in the technology deployment environment towards measurement of technology adoption. By integrating other technology adoption models, the UTAUT proposed a unified model with four determinants influencing both behavioral intention (BI) and actual use of a technology; these determinants are:

- **Performance expectancy (PE):** perceived gains on task performance by adopting the targeted technology
- **Effort expectancy (EE):** ease of use in adopting the targeted technology
- **Social influence (SI):** degree to which significant others influence the user’s intention or actual use of the targeted technology
- **Facilitating conditions (FC):** perceived level of organizational and technical infrastructure support to facilitate use of the targeted technology

Attitude towards usage of SRS as a learning tool in classroom was assessed with the Unified Theory of Use and Acceptance of Technology (UTAUT) (Venkatesh et al., 2003), a 5-domain 20-item instruments on a 5-point
likert scale measuring performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), and satisfaction and behavioral intention to continue use of the technology adopted (S/BI).

- **Revised Two-Factor Study Process Questionnaire (R-SPQ-2F)**

Learners’ learning approaches were assessed with the 20-item Revised Two-Factor Study Process Questionnaire (R-SPQ-2F) (Biggs et al., 2001), with learners classified as adopting surface or deep learning approaches for outlining their motives and strategies towards their learning.

- **Higher-Order Learning and Collaborative Learning – National Survey of Students’ Engagement (NSSE-HO / NSSE-CL)**

Students’ generic learning outcomes were captured with two subscales, higher-order learning (NSSE-HO) and collaborative learning (NSSE_CL) from the National Survey of Student Engagement 2013 (Indiana University Center for Postsecondary Research, 2013). Higher order learning refers to challenging learning tasks including applying information learned in solving practical problems, synthesizing information from multiple sources, and forming new ideas from information sourced. Collaborative learning refers to the degree that students master skills and concepts through discussion and team learning with other students toward formative and summative assessments.

3 Data Analysis

Quantitative data derived from this study was analyzed with a structural equation model (SEM). Data were analyzed using confirmatory factor analysis (CFA) and structural equation modeling (SEM) (Bollen, 1989). Descriptive and correlations were generated with the IBM SPSS Statistics 22 software. All SEM models were estimated with the IBM SPSS Amos 22 software. Standard maximum likelihood estimations were applied in the SEM with no observed missing data. The research model on students’ learning outcomes was based on two latent variables, namely satisfaction and behavioral intention to use of SRS in class in the Unified Theory of Use and Acceptance of Technology (UTAUT), and students’ deep approach to learning with the Revised Study Process Questionnaire - 2 Factor Structure (R-SPQ-2F). The research model is illustrated in Figure 1 and the research hypotheses are listed in Table 1.

![Research model](image)

**Figure 1**: Research model

**Table 1**: Research hypotheses

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Performance expectancy (PE) will have a positive and significant influence on satisfaction and behavioral intention to use SRS (S/BI)

Effort expectancy (EE) will have a positive and significant influence on satisfaction and behavioral intention to use SRS (S/BI)

Social influence (SI) will have a positive and significant influence on satisfaction and behavioral intention to use SRS (S/BI)

Facilitating conditions (FC) will have a positive and significant influence on satisfaction and behavioral intention to use SRS (S/BI)

Satisfaction and behavioral intention to use SRS (S/BI) will have a positive and significant influence on deep learning approach (Deep)

Deep learning approach (Deep) will have a positive and significant influence on NSSE Higher-Order Thinking / Learning (NSSE-HO)

Deep learning approach (Deep) will have a positive and significant influence on NSSE Collaborative Learning (NSSE-CL)

The proposed model fit was evaluated using conventional fit indices (Hu and Bentler, 1999) including Chi-Square Statistics ($\chi^2$), global fit index (GFI), Tucker-Lewis index (TLI), comparative fit index (CFI), incremental fit index (IFI), root mean square error of approximation (RMSEA), and the standardized root mean square residuals (SRMRs).

4 Results

4.1 Participants and demographics

A total of 1623 undergraduate students from 39 courses at a 4-year university participated in this study. The mean age of participating students is 18.93 years old, with 30.44% of the study sample being freshmen (year-1 students) at age 17 or below, 67.1% being sophomores between age 18-23 or below, and 2.46% being mature students age 24 or above. Figure 2 illustrated the distribution of participants’ age.

Figure 2: Age of participating students
Students in this sample represented a balanced mix of academic disciplines, with business and health/social sciences students accounting for 60% of the study population while science/technology/engineering (STE) students (19%), tourism & hospitality students (16%), and humanities/design students (5%) rounded up the remaining 40% of the study sample. Figure 3 depicted distribution of students’ disciplines.

Figure 3: Disciplines of participating students

Structural model and path coefficients of learning technology use, deep learning, and learning outcomes

Figure 4: Structural Equation Model of UTAUT constructs, behavioral intention and satisfaction towards learning technology and R-SPQ-2F deep learning approach on NSSE higher-order learning and collaborative learning
The proposed structural model is illustrated in Figure 4, where Table 2 presents correlation among model variables and Table 3 highlights the critical ratios of exogenous (predictor) variables included in the research model. Table 4 presents the path coefficients and corresponding statistical significance for each of the hypotheses.

Upon fitting the study data, results of the proposed research model exhibited a good fit: ($\chi^2 = 3126.104$, df = 682, $\chi^2$/df = 4.584, GFI = 0.891, TLI = 0.934, CFI = 0.939, IFI = 0.939, RMSEA = 0.047, SRMR = 0.038). Overall, five out of seven hypotheses were supported by the data.

Two out of four hypotheses (H1 and H2) representing the relationship among the main UTAUT constructs (PE, EE) to S/BI were supported in this study. As shown in Table 4, performance expectancy (PE) positively predicted satisfaction and behavioral intention (0.415, p < 0.001); therefore, H1 was supported. Similarly, effort expectancy (EE) significantly predicted satisfaction and behavioral intention (0.258, p < 0.001); therefore, H2 was supported.

The hypotheses that were not supported was H3: SI to S/BI and H4: FC to S/BI. Social Influence (SI) (2.644, p=0.008) and Facilitating Condition (FC) (1.630, p=0.103) did not significantly predict satisfaction and behavioral intention to continual use of SRS; therefore, H3 and H4 were not supported.

Satisfaction and behavioral intention to continue use of SRS (S/BI) significantly predict deep learning approach (Deep) (0.287, p < 0.001); therefore, H5 was supported.

Regarding learning outcomes, deep learning approach (Deep) positively predicted usage higher-order thinking and learning (NSSE-HO) (0.523, p < 0.001) and collaborative learning (CL) (0.153, p < 0.001); thus H6 and H7 were supported.

**Table 2: Correlation coefficient of model variables**

<table>
<thead>
<tr>
<th></th>
<th>EE</th>
<th>SI</th>
<th>FC</th>
<th>Satisfaction</th>
<th>Deep</th>
<th>HO</th>
<th>CL</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>.690</td>
<td>.729</td>
<td>.676</td>
<td>.783</td>
<td>.468</td>
<td>.226</td>
<td>.184</td>
<td>-.134</td>
</tr>
<tr>
<td>EE</td>
<td></td>
<td>.637</td>
<td>.744</td>
<td>.738</td>
<td>.387</td>
<td>.254</td>
<td>.182</td>
<td>-.103</td>
</tr>
<tr>
<td>SI</td>
<td></td>
<td>.711</td>
<td>.713</td>
<td>.463</td>
<td>.239</td>
<td>.223</td>
<td>-.083</td>
<td></td>
</tr>
<tr>
<td>FC</td>
<td></td>
<td></td>
<td>.726</td>
<td>.421</td>
<td>.307</td>
<td>.240</td>
<td>-.100</td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
<td></td>
<td></td>
<td>.420*</td>
<td>.231*</td>
<td>.182*</td>
<td>-.117</td>
<td></td>
</tr>
<tr>
<td>Deep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.386*</td>
<td>.283</td>
<td>-.053</td>
<td></td>
</tr>
<tr>
<td>HO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.428*</td>
<td>.037</td>
<td></td>
</tr>
<tr>
<td>CL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.017</td>
</tr>
</tbody>
</table>

PE: Perceived ease of use; EE: Effort Expectance; SI: Social influence; FC: Facilitating Conditions; Deep: Deep approach; HO: Higher Order Thinking; CL: Collaborative Learning; **p < 0.01; *p <0.05
Table 3: Standard error and critical ratios for each of the parameters

<table>
<thead>
<tr>
<th>Estimate</th>
<th>S.E.</th>
<th>C.R.</th>
<th>P</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>0.452</td>
<td>0.023</td>
<td>20.034</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>EE</td>
<td>0.531</td>
<td>0.024</td>
<td>21.744</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Si</td>
<td>0.405</td>
<td>0.020</td>
<td>19.937</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>FC</td>
<td>0.316</td>
<td>0.019</td>
<td>16.922</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Age</td>
<td>6.714</td>
<td>0.236</td>
<td>28.478</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

Table 4: Structural equation model path coefficient results

<table>
<thead>
<tr>
<th>Path (Hypothesis)</th>
<th>Standardized path coefficient (Beta)</th>
<th>t-value</th>
<th>Hypothesis testing result</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1 S/BI &lt;- PE</td>
<td>0.415</td>
<td>8.839***</td>
<td>Supported</td>
</tr>
<tr>
<td>H2 S/BI &lt;- EE</td>
<td>0.258</td>
<td>6.555***</td>
<td>Supported</td>
</tr>
<tr>
<td>H3 S/BI &lt;- SI</td>
<td>0.249</td>
<td>2.644n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>H4 S/BI &lt;- FC</td>
<td>0.16</td>
<td>1.630 n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>H5 S/BI &lt;- Deep</td>
<td>0.287</td>
<td>16.018***</td>
<td>Supported</td>
</tr>
<tr>
<td>H6 NSSE-HO &lt;- Deep</td>
<td>0.523</td>
<td>14.466***</td>
<td>Supported</td>
</tr>
<tr>
<td>H7 NSSE-CL &lt;- Deep</td>
<td>0.153</td>
<td>5.014***</td>
<td>Supported</td>
</tr>
</tbody>
</table>

Model fit indices: χ² = 3128.587, df = 683, χ²/df = 4.581, GFI = 0.891, TLI = 0.934, CFI = 0.939, IFI = 0.939, RMSEA = 0.047, SRMR= 0.038; ***p < 0.001; n.s. Not significant.

5 Discussion and implications

A model of 3 latent factors, including two factors from UTAUT in Performance Expectancy and Effort Expectancy along with Deep Learning Approach from the SPQ, were identified in the structural model on students’ learning outcomes upon adopting SRS in classes.

Hypotheses H1 & H2 were statistically significant, indicating evidence for substantial influence on behavioral intention to adopt education technology based on perceived performance and effort expectancies. Particularly, the observed effect size of performance expectancy with standardized coefficient of 0.415 in the research model was substantially larger than average coefficient estimated in a recent meta-analysis on UTAUT of 0.343 (Dwivedi et al., 2011).

Performance expectancy may play a significant role in adoption of education technology towards learning goals in the Asian culture. It has been suggested that Asian, particularly Chinese students, tend to value the avoidance of poor performance and extrinsic motivation (D’Lima et al., 2014) high in formulating their learning goal orientation. If adoption of certain educational technology could significantly improve on their performance and avoid failure, it is likely that students would value performance expectancy in making decision to adopt technology for learning over other factors.

Hypotheses H3 & H4 did not reach statistical significance in the current research model. While Social Influence (SI) and Facilitating Conditions (FC) did not predict satisfaction and behavioral intention, the overall model nonetheless suggested linkage between readiness towards SRS and tendency to engage in deep learning, which in turn positively predict higher-order thinking and learning and collaborative learning with peers.
Though regarded as one of the more significant constructs in UTAUT, the contribution of SI is subject to further investigations since it is sometimes omitted in systematic review and meta-analysis because of its context and cultural specificity (Lidia et al., 2007). Indeed, non-significant path between SI and other model variables parallels findings about the inconsistent relationship of this construct with the overall model in the technology adoption literature (Lee et al., 2003) in general. Exclusion of SI in the UTAUT-based research model has also been resonated in a similar non-significant finding from a study population of Asian origin (Koh et al., 2010). Further investigation of cross-cultural variation of this dimension is required to delineate the role of social influence in education technology adoption in the Asian context, particularly when level of individualism and avoidance of uncertainty that vary significantly across cultures (Nistor et al., 2014).

In the higher education context, findings on the role of facilitating conditions (FC) in UTAUT have been mixed – from key correlates to effort expectancy (Terzis and Economides, 2011)] to non-significant factor excluded from the research model (Al-Hujran et al., 2014). A possible explanation to the non-significant path observed in the current study is that the participating classes using SRS were part of an ongoing e-learning project that provides centralized support and training on developing and delivering SRS questions in classes. Further analyses are required to examine whether uniformity in technical and user support explains the lack of variation in terms of facilitating conditions towards technology adoption.

Hypotheses 5-7 were supported in the research model presented. Findings from the current study confirms the effect of SRS on encouraging complex cognitive effort (Brady et al., 2013a) and collaborative learning (Jones et al., 2012, Blasco-Arcas et al., 2013), while bridging these learning outcomes via activation of deep learning approach being facilitated by satisfaction and intention to use SRS. Soliciting students’ responses in learning environment has been suggested to facilitate retrieval-based learning (Karpicke and Grimaldi, 2012, Campbell and Mayer, 2009) Through retrieval of recently acquired information, students consolidate their acquired information in the higher education setting with active learning effort and timely feedback (Lantz and Stawiski, 2014). The student-initiated effort in SRS also resonates with the generation effect (Hirshman and Bjork, 1988, Lantz, 2010), a theory in cognitive and learning psychology hypothesizing better memorization and retention in learning when individuals are required to generate learning artifacts rather than simply receiving and encoding information. These cognitive processes in a learning context possibly account for the demonstrated association between deep learning approach and readiness to SRS demonstrated in this study.

The presented research model highlights the long-term impact of using SRS in classes beyond immediate gains such as students’ attention and class engagement (Velasco and Çavdar, 2013, Vaterlaus et al., 2012, Kay and LeSage, 2009, Morling et al., 2008). Appropriate and effective use of SRS should be regarded as an integral mean to achieve deep learning strategies towards enriched, applied, and collaborative learning, which are considered high-impact practices in higher education in the 21st century (Kilgo et al., 2014).

During SRS session, the level of students monitoring their cognitive effort could vary substantially, leading to corresponding variation in learning outcome through SRS. Recent studies suggested that SRS questions and subsequent students’ responses effect moderately on heightening students’ metacognitive effort by verifying their knowledge mastery with the responses presented and discussed in classes (Brady et al., 2013b, Brady et al., 2013a);Schell, 2013 #1066). The current model could possibly address students’ varying level of metacognitive activities during SRS sessions with deep learning approach, an orientation calling for metacognition and mastery of knowledge acquisition, partially contributing to students’ motivation and effort to think through the questions presented towards a reasoned response.

5.1 Limitations of the current study

Learning approach and attitude towards acceptance and use of technology are limited and subjected to recall and social desirability biases by self-reported items from survey. In delineating the moderating effect of learning approach between intention and behavior, further inquiries through qualitative data in a mixed method design would provide more accurate explanations on the findings currently presented in this paper.

Implication for learning with technology in higher education:

Findings from the present study suggested that using SRS, when students are properly motivated with its utility on learning performance, could influence deep learning approach that in turn predicts higher-order
learning activities such as higher-order thinking and collaborative learning. Teachers using SRS to facilitate deep learning could focus on SRS questions that are deemed fitting to such learning approach, such as critical thinking or application questions (Bruff, 2009) that optimize stimulations in their students towards higher-order learning.

References


Visualisation and Gamification of e-Learning and Programming Education

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Abstract: Courses in virtual learning environments can leave recently enrolled participants in a state of loneliness, confusion and boredom. What course content is essential in the course, where can more information be found and which assignments are mandatory? Research has stated that learner control and motivation are crucial issues for successful online education. This paper presents and discusses visualisation as a channel to improve learner’s control and understanding of programming concepts and gamification as a way to increase study motivation in virtual learning environments. Data has been collected by evaluation questionnaires and group discussions in two courses partly given in the Moodle virtual learning environment. One course is on Game based learning for Bachelor’s programmes, the other is a course on e-learning for university teachers. Both the courses have used progress bars to visualise students’ study paths and digital badges for gamification. Results have also been discussed with teachers and pedagogues at a department for computer and systems sciences. Furthermore, two visualisation prototypes have been designed, developed and evaluated in programming lectures. Findings indicate that visualisation by progress bars is a good way to improve course participants’ overview in online environments with rich and multifaceted content. To what degree the visualisation facilitates the course completion is hard to estimate, and like students have different learning styles, they also seem to have different visualisation needs. Gamification by digital badges seems to have various motivational impacts in different study groups and in traditional university programmes the traditional grades seem to be the main carrots. Finally, it seems that software visualisation might be a promising path to enhance programming education in the 21st century.

Keywords: Visualisation, Gamification, Programming education, Virtual learning environments, E-learning

1 Introduction

A general trend in the 21st century is that traditional face-to-face rostrum teaching and learning at university level is transformed to courses including online activities reaching various percentages of blended learning and dual modality (Graham, 2006; Lim & Morris, 2009; Park & Choi, 2009). If these new online virtual learning environments are not designed carefully, learners can get stuck in a state of confusion (Hara & Kling, 2000) and loneliness (Brown, 1996). Online learning must, like traditional education, be designed with a human touch otherwise there is a risk for low motivation (Keller & Suzuki, 2004) and high drop-out rates (Park & Choi, 2009).

A critical phase for every online course is the learner’s first login. Common question that often arise are: What course content is essential in the course? Where can I find more information? Which exercises and assignments are mandatory to complete the course? The identified problem with high drop-out rates in the inception phase of online courses might be caused by the students’ cognitive overload. Learning of new content or skills, for which a schema in long term memory is lacking, can cause (the) learner’s limited working memory (to) overload. This overload can result in unconfident and even anxious learners, which can lead to a failing learning process and course drop-out (Tyler-Smith, 2006).

Results in a report on online education at the Open University in UK indicate that 38% of e-learners leave courses before submitting their first assignment (Simpson, 2004) which suggests that a learner’s initial interaction with an online platform may have a significant impact on further studies (Tyler-Smith, 2006). Research has also stated the importance of learner control (Chou & Liu, 2005) and learners’ motivation (Keller & Suzuki, 2004). This study will have a focus on how the concepts of visualisation and gamification might increase learners’ self-control in online learning environment.

Teaching programming to novice students is classified as hard, especially to weaker students. It is perhaps not surprising since computer programs and algorithms are abstract and complex entities, that involve concepts and processes, which are often found difficult to teach and learn ((Guzdial & Soloway, 2002; Lahtinen, Alamutka & Jarvinen, 2005; Eckerdal, 2009). Research on multimodal teaching has shown that adding more
channels for the knowledge transfer can facilitate learning in general. This could then be of particular use in programming education, which is a relatively abstract form of both knowledge and skills. Multiple forms of representation or modes, each performing its semiotic labour, also benefit the understanding (Kress, 2010). Further, the way knowledge is presented is relevant to the content and the form can be seen as part of the content, instead of separate from the content (Rostvall & Selander, 2008). Learning is thereon focused upon as communication and sign-making activities; how the information is processed and transformed into knowledge within a certain institutional setting (Selander & Kress, 2010).

In this paper, a design theoretic multimodal perspective to teaching and learning programming has been applied and the approach builds on adding an extra channel of communication between teacher and student. The channel selected is a visual display of the dynamic parts of program execution, usually called software visualisation. Software visualisation aims to facilitate learning and understanding of programming and simplified it can be seen as the utilization of graphical representations, in form of text, pictures and animations, e.g. a rapid display of a sequence of pictures. Two main underlying concepts of software visualisation are program visualisation and algorithm visualisation. Program visualisation is a graphical representation of a running program, i.e. software code that is executing and algorithm visualisation is a graphical representation of an algorithm, i.e. a set of instructions that are carrying out a specific task.

1.1 Aim of the study

The aim of the study is to describe and analyse techniques for visualisation and gamification in virtual learning environment, and to discuss how they might increase learners’ control and motivation.

2 Extended background

The two techniques to increase learner control and motivation that are described and discussed in this study are visualisation and gamification. Both concepts have been hyped and extended to various definitions during the last decade but in this study the terms are used as they are defined below.

2.1 Visualisation

Students of today need more skills to be able to work efficiently and manage their education than students a few decades ago, as the integration of technology and e-learning has exploded. One of these skills is visual literacy, which is also one of the most critical competencies (Mnguni, 2014). Selander and Kress (Selander & Kress, 2010) are significantly taking into account that learning is largely shifted from local to global learning environment and describes learning from a multimodal perspective, where resources, in many cases visualisations, has a central role.

For decades it has been common to use graphical visualisations as a learning aid. And static visualisations are exquisitely capable of showing the appearance or the constitution of something. However, visualisations such as animations are able to provide for a more exhaustive understanding of abstract and dynamic entities, since changes and states can be animated step by step.

Selander and Kress focus learning as sign-making activities and communication. The common base for the sign-making activities consists of multimodality and didactic design. Multimodality is based upon the different resources (visualisations included) that are used for interpretation and to create meaning. However, words, symbols, visualisations etc. do not mean anything itself, rather they are assigned its meaning from the context in which they are created and used.

Didactic design is used as a term for how individuals constantly recreate (re-design) information in their own meaning-making processes. It is also used as a term for how to form social processes and create learning conditions. Further, Selander and Kress mean that all the arrangements produced to facilitate learning, such as visualisations, are all design for learning. Selander and Kress have developed a model that summarizes a formal learning design sequence (Figure 1), where the information is first being processed and then transformed into knowledge.
Some potential resources, like visualisations, are available in a learning situation. There is a purpose of the activities and the engaging activities also relates to various degrees of clear institutional patterns, routines and habits. Selander and Kress believe that those are important aspects where an activity or a learning sequence begins. The form of arrangement created for certain activities is set. The setting also includes individuals’ interpretation and framing of the situation and the way the individual position itself. Resources used, i.e. visualisations are transformed and formed in a primary transformation unit. It can be seen as a transformation cycle, in which information is selected, processed and combined in a new way, to form a representation. To reach a coherent new representation, the processes are neither linear nor circular, but about exploratory, sketchy and hypothetical processes. Selander and Kress believes that interaction, dialogue and positioning are important factors to understand the direction that the activities can take. The choices made in a learning process can be seen as fixation points where a meaning and a basis for a possible continuation temporary is locked. What one chooses depends on what catches the attention at a particular time, and what is perceived as an interesting challenge, according to Selander and Kress. Further, the resources that are used to mould and shape ones understanding is connected with what is perceived as an obvious, reasonable or possible resource in a situation.

In the transformation, one uses, combines and creates new representations by using the resources available, i.e. visualisations, in a situation. Those representations are more sketchy representations processed along the way. The representation which forms the transition to the second transformation unit in fig 1, is referred to a more finished fixation of an individual’s understanding of a phenomenon, by Selander and Kress. In the second transformation unit individuals’ knowledge and understanding is represented. And a new transformation cycle of discussion, assessment and meta-reflection on the more finished representation, and on the learning process as a whole starts.

2.2 Gamification

According to Deterding et al (2011) “‘Gamification’ is the use of game design elements in non-game contexts”. Unpacking their definition, Deterding et al, argues that gamification is more about gaming than playing – there are rules to follow. Gamification use elements of game design but can’t be considered as full-fledged games. There are several levels of game elements where a gamified system can borrow its design; Game interface design patterns, Game design patterns and mechanics, Game design principles and heuristics, Game models and Game design methods. In other words a gamified system is designed to look and/or feel like a game but it
does not go all the way. These game elements are used for other purposes than being part of a game, thereof the non-game context.

Karl M Kapp defines gamification as “using game-based mechanics, aesthetics, and game-thinking to engage people, motivate action, promote learning, and solve problems.” (2012, p. 10) This definition considers the purpose of gamification and points at the pedagogical use of the concept; “to gain a person’s attention and to involve him or her in the process you have created.” (p.11).

In gamification, motivational theory is really important, where for example the Self-Determination Theory (SDT) (Ryan & Deci, 2000), ARCS (Keller, 2010), The Taxonomy of Intrinsic Motivation (Malone & Lepper, 1987), divides motivation into extrinsic and intrinsic motivation. Extrinsic motivation is motivation due to external rewards and intrinsic motivation refers to rewards that come from within a person. Keller (2010) state that “it is more common to find that there are elements of both [intrinsic and extrinsic motivation] that are intertwined in any particular situation”. As an example he mentions that even if you like your work, you probably wouldn’t do it without the salary.

On the one hand extrinsic motivators are very useful if they lead to intrinsically motivated learning activities. But on the other hand if the learners already are intrinsically motivated, extrinsic motivators can undermine the intrinsic motivation. Kapp especially states “extrinsic reward structures of engagement-contingent rewards, completion-contingent rewards, and performance-contingent rewards all undermine intrinsic motivation in most cases” (Kapp, 2012).

In his argumentation around satisfaction, Keller (2010 p.53) states “one of the most rewarding results of performance-oriented instruction is to use the newly acquired skills or knowledge”. But there is not always possible to put new knowledge into use and the learner can also lack intrinsic motivation. Here Keller suggests the use of extrinsic reinforcement. He also states the importance of equity, to ensure that the course outcomes are consistent with what has been communicated.

It’s easy to think that gamification is all about badges, scores and leader boards, which would be a significant part of a behaviourist concept. Bíró (2013) states that gamification has more in common with the behaviourist concept than with the cognitivist, constructivist and connectivist approaches. In behaviourism though, the learner is considered to be a reactive and instinct-driven individual, motivated extrinsically by an active teacher to learn the external knowledge that the teacher has defined as the right one. But within gamification theory the learner is thought of as a conscious proactive individual with an intrinsic motivation. Knowledge seems to be both internal and external.

Bíró (2013) points out that “gamification considers the visual dimension of the learning process very important, especially the visualization of the advancement in the learning process and the chosen learning path.” In other words visualisation theory can bring a lot of important aspects to gamification theory.

2.3 Software visualisation

Software visualisation is either a static or a dynamic and animated visual representations of information about software systems. In this study, software visualisation is referred to as graphical representations, in form of animations of programs and algorithms. Further, software visualisation can be seen as means of communication between the designer of the visualisation and the user of the visualisation. Moreover, it is associated with principles from cognitive psychology and perception (Petre, 1995). Traditional programming education has focused on the transmission of a complete mental model to the students. With visualisation the students are offered additional ways to realise how the dynamics of the programs work and several paths to gain knowledge are offered by different potential learning sequences. Two main underlying concepts of software visualisation are program visualisation and algorithm visualisation. Their definitions are outlined as follow:

- Algorithm visualisation – a high-level description of a piece of software is visualised (Price, Baecker, & Small, 1993), not related to the program’s source code and without details (Myller, 2004), often used for a better understanding of the procedural behaviours of the algorithms (Hundhausen, Douglas & Stasko, 2002).
• Program visualisation – programs are mapped to be represented graphically (Roman & Cox, 1993). Thus, different states of the program or a running program are illustrated graphically, while the program is defined textually, for example in form of source code (Myers, 1986).

Both these concepts are employed in the experiment, in trying to convey knowledge about the execution of computer programs, but mainly program visualisation is being used in the two animations: iteration visualisation and object visualisation. They differ in their aims, in what learning hurdles they are trying to bridge. While iteration visualisation mainly deals with problems of understanding the dynamic behaviour of computer code, object visualisation also deals with conceptual problems of understanding objects in addition to dynamic properties.

2.4 Software visualisation with a design theoretic multimodal perspective

In the design theoretic multimodal perspective, the learning is focused as a signs-interpretive and signs-creative activity, where information is transformed and new representations of knowledge are created. Further, (Selander & Kress, 2010) view learning as meaning-making communication in the context of specific situations in an institutional setting. Design shapes objects as well as conditions for communication and in the context of didactic design, design creates new meaning. Multimodality is based on the various kinds of resources that can be used to interpret the world and create meaning.

The teaching and learning of programming with the help of code visualisation can be seen as formalised learning design sequences. In this study, the first setting arranged is the animation of an executing computer program and the second setting examined is an animation of an executing algorithm. Presenting animations for the students represented the learning sequences, where the aim was to study whether an extra added visualisation channel could offer extra possibilities of meaning-making and learning. The added channel consisted of a visual display of the dynamic parts of program execution; one about imperative programming and one about object-orientation. Imperative programming and object-orientation are two typically hard concepts to teach and learn, therefore these concepts were tested. To guide the student’s attention to the key aspects in the context of the moment, and for the students to more easily orient themselves, e.g; see patterns, interpret, frame, position themselves in the context and create meaning, each learning sequence is supplemented with narration. Additionally, the program code is also continuously visible. Each learning sequence is framed by the fact that a sequence begins when the animation begins and ends when the animation ends.

Transforming and forming are two central sequences in Selander’s model of a formally framed learning design sequence. In this study, transforming and forming are the processes where the students need to interpret, process and transform the information in the settings to representations of their own. It can be looked upon as a transformation cycle, where information is selected, processed and combined in a new way, to form a representation. The processes are neither linear nor circular to gain a new coherent representation. Instead, it is about exploratory, sketchy and hypothetical processes. In the attempts of transforming information, aspects as iteration of processing information, interaction and dialogue are of importance. In this study, the settings actually consist of the classical model: sender – message – channel – receiver and the transforming and forming of information refers to individual reflections and processing in the representation phase.

3 Methods for data collection

Data has been mainly been collected from course evaluation questionnaires and from discussions and comments at course seminars. Students study patterns were analysed by their individual progress bars where completed activities are marked. Gamification and visualisation ideas have also been discussed with colleagues at the department where the authors are employed.

The overall approach is a case study, with the case study strategy defined as an investigation of a real world process or phenomenon (Yin, 1989). To explore the chosen processes in depth a mix of data collection methods are often used (Creswell, 2009) where the combination of different data sources should support a deeper understanding of the investigated process (Remenyi, 2012).

Evaluation questionnaires were given in Swedish and all quotations in the article have been translated to English by the authors. For ethical reasons all informants are kept anonymous and screen shots have been

edited in Photoshop to remove names and other details that might be associated with individual course participants.

To study how the software visualisations worked, a learning experiment was devised. Two typically hard concepts for beginners were selected, one in imperative programming and one in object-orientation. For the imperative part, the dynamics of a for-loop was chosen. For the object-orientation part, the dynamics of an object in the form of instantiation, inheritance and method calls was chosen. These two prototypes were shown to first year undergraduate programming students on two separate occasions (one for each prototype).

Students were divided randomly into two groups, one experiment group and one control group. There was no announcement of the lectures being different and the students were not given a choice of which lecture to participate in. For the iteration visualisation prototype, the experiment group consisted of 85 students and the control group of 72 students. For the object visualisation prototype, the experiment group consisted of 59 students and the control group of 57 students. In each case, the control group was given an ordinary lecture, consisting of a teacher talking the students through the program code and at the same time drawing on a whiteboard. Thus, they were offered the lecture through the ordinary channels of text and voice. For the experimental group, the visualisation was added to the content shown to the control group. Thus, they were offered an additional modal channel of dynamically seeing the code being executed in animated form.

4 Courses and software visualisation experiments

Both courses have been given twice during the autumn semesters of 2013 and 2014 at a department for Computer and Systems sciences. The courses have large variations regarding content and activities but a common denominator is the tendency to test and evaluate new blended learning techniques.

4.1 The course on game-based learning

A syllabus consisting of 9 lectures, 2 workshops and 5 assignments builds a foundation for the final project where students should design, implement and present an educational game. Course content as well as examination is a mix of theoretical and practical work where reading and code analysis is combined with essay writing and programming. Various guest lecturers present their niches in Game-based learning, design and programming. Literature and teaching sessions also includes gamification, pedagogy and accessibility aspects. Practical programming assignments where the students build games are interwoven with theoretical exercises where short essays are posted and discussed online.

Discussion fora and course content with recorded lectures and workshops are available in the Moodle virtual learning platform. Almost all students take the course in a blended learning mode but some participants have completed the full course, with an exception for the final seminar, in distance mode. According to the Bologna model, 7.5 credits (ECTS) correspond to 5 weeks of fulltime work but this course is given in parallel with another course where both courses have a 10 week frame. Closed assignments with strictly given instructions are combined with open tasks where students are free to design and create their own solutions. The more closed assignments are exercises in HTML5, CSS, JavaScript, jQuery and game creation techniques. The aim with these more technical assignments is to provide the skills needed to implement the game in the final project. For the higher grades the project submission should consist of a unique, playable learning game, tested and with the development process documented.

Moreover, game design should, for the higher grades, also be aligned to a pedagogical or motivational theory/model. The game idea should also be presented in the students’ ePortfolio that has been created as one of the mandatory assignments as well as in the Moodle platform with the basic game idea demonstrated in a video. Finally at the examination seminar the created games are presented and discussed to get feed forward for further game development.

At the examination seminars there is also a discussion on course activities and course structure. In one seminar at the end of the first version of the course there was a discussion on how the course outline might be presented more clearly. As a result of this debate the individual progress bars, that are evaluated in this study, were added to the course and mapped to the course activities. The progress bars in the second version of the course had the standard design that is depicted below in Figure 2.
4.1 The course on e-learning for university teachers

The aim of this course is to teach university teachers about the development of digital learning resources. It has been conducted two times with some enhancements the second time. The courses were mainly held online in the Moodle learning platform with a lot of pre recorded video films, articles and URLs to web resources. The topics discussed were about interaction design, gamification, media production, pedagogy and motivation.

The first course, conducted in late fall 2013, was worth 2.5 ECTS at 25% pace for six weeks. There were three assignments; 1) Course analyses, 2) Concept development/Prototyping, 3) Production. In the production phase the participants could choose between creating a fully working learning resource or a prototype for demonstrating a more advanced concept. The assignments were posted in online forums and peer-reviewed by the participants.

There were two online seminars in Acrobat Connect and an all-day event on location at the department. At the event the participants were introduced to production software like PowerPoint, Camtasia and Articulate Storyline. They also planned and performed talk show interviews in the department’s professional video studio.

The course evaluation was positive. All participants thought that as a result of the course they were going to change their way of teaching and that it had been really useful for them. The most negative feedback was that the workload was too heavy for the credits. The analytics from Moodle revealed that the participants only watched a few of the videos before the online seminars and a lot of the activities remained unseen after the course had come to an end.

The second course (fig 3) was conducted late fall 2014 with some enhancements. The credits were raised to 3 ECTS and the time stretched to eight weeks. A progress bar was implemented to indicate the mandatory activities coupled with a course badge as an end goal. To complete an activity and mark it as completed in the progress bar the participants had to answer one to three easy multiple-choice questions about the key concepts. These small quizzes were only used to activate the learners and for diagnostics but not for examination.

The online forums were also connected to the progress bar. First they were marked as completed after the participant had started one discussion and answered two discussions. But this was obvious a design flaw because they could start discussions without submitting any assignment, for example to ask a question and in
the same way they could answer a discussion without posting any peer-review. This was changed to completion by pass/fail instead. The course format was changed to *Weekly format* were the modules are divided into weeks which are marked with a bright colours also indicating progress.

In the first edition of the course the first real world meeting took place the second week during the all-day-event. The two online seminars were conducted week one and three. In the second edition the group didn’t meet face to face until the fourth week. Both of the online seminars took place the first and third week. To compensate for the lack of contact with the teacher and the other participants a new introduction video was recorded with the purpose of simulating a sense of presence. The course leader was filmed like he was standing inside of Moodle presenting the course and the graphical user interface talking directly to the user.

![Progress bar, completion checkboxes, the badge and the introductory video where the teacher interacts with the graphical user interface](image)

**Figure 3**: Progress bar, completion checkboxes, the badge and the introductory video where the teacher interacts with the graphical user interface

### 4.2 Software visualisation prototypes

The iteration visualisation prototype and the object visualisation prototype examined in this study are designed and developed by the first author of this paper. Both prototypes will be explained in detail below in section 4.3.1 and 4.3.2.

### 4.3 Iteration visualisation prototype

The iteration visualisation prototype begins with the display of the class, in which the algorithm is found. The algorithm used is a for-loop that represents iteration. A variable `x` is declared in the *class For* and later used in the visualisation of the for-loop. This visualisation proceeds with the visualised execution of the for-loop, depicting the operations of the for-loop and the order in which the operations are performed. An illustration of the gradually emerging result of the executing for-loop in the Command Prompt is also illustrated. The
algorithm is gradually visualised from plain program code, to the illustration of the code, to the transformation of the illustrated code, into the illustration of the result of the algorithm.

The window consists of two frames. First, there is one minor frame in the upper left corner. In this frame, the program code, which contains the for-loop is displayed. Second, there is one large frame in the centre, aligned to the right. In this frame, the illustration of the for-loop being processed is presented. The gradually emerging result of the for-loop is displayed in the lower left corner. A coloured square, which corresponds to the UML notation is used, to illustrate the class, in which the for-loop is found. Variables are represented as boxes that hold the values of the variables. The boxes have the same colours as the objects, in which they are found. The names of the variables are placed on the left side of the boxes. The iteration visualisation prototype is complemented with textual clarifications of different states in the iteration visualisation. The textual clarifications are presented in form of small commentary text areas, being visible as the visualisation proceeds. The contours of the text areas and the clarification text written inside the text areas are red. To follow each round (iteration) of the for-loop, the number of each round, is displayed.

The colour of the display, i.e. the numbers of each round is red. Program code in the upper left frame is highlighted with a yellow translucent colour. The highlighting starts from the beginning of the code, row by row, until the end of the code. The parts of the program code that is highlighted for the moment, is the part that is visualized in the large frame in the centre. This is to facilitate the focus of what in the code is being visualised at a certain moment. The iterative process of the actual algorithm is highlighted as well. The highlighting illustrates the operations of the for-loop and the order, in which the operations are performed, when executing the for-loop.

Figure 4: A snapshot of the iteration visualisation prototype at the beginning of its process

4.3.1 Object visualisation prototype

To illustrate the object-oriented view, the object visualisation prototype begins with a display of a core outline of the classes. This is to scope the overall picture of the program’s complexity. The object visualisation then proceeds to illustrate the dynamics of the running program. In addition, an illustration of the gradually emerging result of the running program on the screen, i.e. the Graphical User Interface, is illustrated. Thus, the program is visualized from plain program code, to the visualisation of the code, to the transformation of the visualisation of the code, into the visualisation of the outcome of the program on the screen. The window is composed of two frames. First, there is one minor frame in the upper left corner. In this
frame, the program code is displayed. Second, there is one large frame in the centre, aligned to the right. In this frame, the illustration of the running program is presented. The gradually emerging result of the program is displayed in the lower left corner.

Coloured squares corresponding to the UML notation is used, to illustrate classes in Java. Different tones of the colours are used to indicate correlations between classes and objects. The names of the classes and the objects are placed above the squares, representing classes and objects, in the upper right corner. The representations of the standard classes are coloured grey. Further, they are combined with unfilled arrows, to illustrate Java’s inheritance structure. This is also consistent with the UML standard concerning inheritance. Reference variables are represented as boxes holding the references. The boxes have the same colours as the objects in which they are found. The names of the reference variables are placed on the left side of the boxes.

Declarations of reference variables are illustrated as growing arrows. The arrows have the same colours as the classes which contain the reference variables. Further, the arrows are expanding from the inside of the variable boxes, until they reach the instantiated objects. When an object is instantiated, the colour of the origin square, representing the class of which the instantiated object belongs to, becomes intensified. This illustrates that the square is now representing the instantiated object. Methods and constructors of classes and objects, which are not standard classes in Java, are illustrated as solid lined ovals on the left border of those classes and objects. In addition, constructors are filled with yellow colour. Methods of classes and objects, which are standard classes in Java, are illustrated as broken lined ovals.

When a method is called, the contour of the oval, representing the method, becomes coloured like the object in which the method is found. The contour of the oval also becomes solid if the method is located in a standard class. When a method call finished executing, the line of the oval representing the method, remains solid and the colour of the line is diminished, to illustrate the executed method call. The program code in the upper left frame is highlighted with a yellow translucent colour. The highlighting starts from the beginning of the code and proceeds until the end of the code. The parts of the program code that is highlighted for the moment, is the part that is visualized in the large frame in the centre. This is to facilitate the focus of what in the code is being visualised at a certain moment.

Figure 5: A snapshot of the object visualisation prototype at the middle of its process
5 Results and discussions

Visualisation by progress bars was appreciated in both courses even if all participants did not use them. Digital badges seem to be a more interesting concept in the course where standard grades are absent. In the course on e-learning for university teachers digital badges were a course component that stimulated participants, but in the course on game-based learning the traditional university grades and credits is the main carrot and some students even see the digital badges as redundant and disturbing.

Most of the students thought that the iteration visualisation prototype was a clear way to learn the phenomenon of the loop and it was relatively easy for them to keep the focus all through the prototype. The object orientation prototype was not that clear for the students in general. The students lost more easily focus and the explanation is probably because the object orientation prototype contains more focus points.

5.1 The course on game-based learning

Not all course participants used the progress bars and a majority was indifferent to the opportunity to achieve a digital badge. Considering the progress bars one student answered that "To be honest, I didn’t recognise it before I should answer this question". However, most respondents seem to have been aware of their individual progress bar and almost all see them as a positive aid for increased overview. Two answers here were that the progress bar, "Kept a good control of what activities that remained ..." and "Good, you get an overview of your work in the course".

The current standard progress bar design in Moodle seem to work for most students but one respondent thinks that "The idea is good but the problem is that you don’t get any feedback on what is missing or what the progress bar represents ...". This is the first version of progress bars in the Moodle virtual learning environment and even if most students understood the feedback idea the design might be improved. From a teachers’ perspective all that were involved in the second version of the course posited that it is a useful tool that can facilitate grading and discussions with the students. Two examples when they are of help for teachers are that the progress bars indicates if students have read the grading criteria and show if all postings have been submitted in discussion assignments.

Progress bars were tested in this course with the aim to visualise and not for gamification but in a course on game-based learning students are aware of gamification and one student answered that: "It gave a good overview and it was easy to check which assignment I’d passed and what was remaining. I don’t know if the purpose was to create a game feeling, if this was the case it failed ...". In a course on game-based learning where the students play and construct games there are already so many gamified activities that it seemed that even the most competitive gamers were indifferent to digital badges. Some participants had a negative attitude and one student explained in his/her answer that: "It adds absolutely nothing when the main achievement of a grade is so much more important and stimulating".

5.2 The course on e-learning for university teachers

The analytics in Moodle shows that some of the participants, of the first course, didn’t even click on the mandatory activities, while all of the participants of the second course not only clicked, they completed the activities on time by answering multiple choice questions.

The course evaluation questionnaire did not reveal much. Most of the five participants thought that the progress bar was good, very good and excellent which can be interpreted as they thought it was useful and motivating. One participant even wrote, “Good – It really gets me going! You want the bar to be green!” which indicate that it can enhance students’ drive to complete tasks. One participant wrote “I did not look that much at it” and one wrote “Good, a simple way to spur”.

The progress bar can also be a good way to spur the teachers, as they can see the progress of the participants’ paths through out the course content. It can be used to see if the engagement is dropping making it possible to early catch upcoming problems. It can be useful in the flipped classroom concept to check if the participants are preparing themselves before the seminars.
The badge seems less meaningful to the participants but still gets positive remarks according to the course evaluation questionnaire. One participant wrote “Always nice with medals and swimming badges, but I really don’t know what to use it for”. Another participant wrote “Fun, but not the reason for me to attend this course :-)”. The course is voluntary. The credits can be used in promotions but there are other courses that give more credits for less work and there are also mandatory courses for the university teachers. It might be concluded that the participants mainly are intrinsically motivated. The badge can be seen as something new and interesting connected to the gamification discourse but not as a main goal of the course.

5.3 The software visualisations

At the end of each lecture, both the experimental group and the control group answered questionnaires. The questions dealt with how the learning situation was perceived, if it was helpful and if it was focused. Since the difference between the experimental group and the control group only was the additional modal channel, the replies indicate differences in the learning outcome from the different settings.

For the imperative for-loop (iteration visualisation prototype), 61% of the respondents in the experimental group replied that the lecture was a clear and effective way of transferring knowledge. For the control group, only 41% replied the same. Thus, there is a 20% difference in perception of the lecture in that respect. Further, 68% in the experimental group and 39% in the control group responded that they did actually receive help in their perceived understanding of the dynamics by attending the lecture. Finally, 85% in the experimental group and 62% in the control group stated that they understood where the focus of the code executing was all through the animation. These results constitute a significant indication that adding the visualisation channel improved the lecture in terms of student learning outcome. That can be explained in a multimodal perspective as a result of offering differing paths for the student’s own design of knowledge, i.e. differing learning design sequences.

For the object-oriented code (object visualisation prototype), 24% of the respondents in the experimental group replied that the lecture was a clear and effective way of transferring knowledge. For the control group, 20% replied the same. Further, 39% in the experimental group and 29% in the control group responded that they did actually receive help in their perceived understanding of the dynamics by attending the lecture. Finally, 60% in the experimental group and 54% in the control group stated that they understood where the focus of the code executing was all through the animation. These results do not show any significant results implying that adding the visualisation channel improved the lecture in terms of student learning outcome as much as in the first case.

According to multimodal design theory, this can be explained by the differences in the design of the prototypes, where the design of the iteration prototype is of a much simpler graphical kind. The object-oriented prototype contains several focus points, leading to a perceived focusing overload. This overload manifests itself in lower improvements by visualisation assisted learning compared to the for-loop. This is not surprising, since the dynamics of loops, while traditionally being hard to comprehend for novice programmers, is not conceptually hard to understand. Objects, on the other hand, are hard both conceptually and dynamically, leading to their animation being multi-focused, i.e. two kinds of learning complications in the same visualisation.

6 Conclusions

Teachers have for many years noticed that students have different study patterns and the idea that students have different learning styles is old and something that probably was discussed in Ancient Greece (Wratcher et al. 1997). The study patterns are also different in different environments with variations between distance education groups and face-to-face teaching and learning (Diaz & Cartnal, 1999). There is definitely a need for new techniques in e-learning to address the issues of boredom and loneliness in online platforms. Visualisation and gamification seem both to be promising concepts in e-learning worth further exploration, even if neither of the techniques will cure all problems or reach all students.

Visualisation by progress bars seems to be a way to increase students’ self-control and facilitate the overview in online environments. Gamification is a trendy phenomenon that, even with careful implementations, probably never will attract all. Since students have different learning styles the solution might be to overload and overlap in courses with the idea that everything not necessarily has to be for everyone.
Even though the badge doesn’t seem to be an ultimate goal for anyone in any of the courses it can be used as a fun gimmick creating a positive feeling in the course. Connected to the progress bar you can speculate that it can be a sort of climax to receive the badge when the last sector of the progress bar turns green.

The amendment of programming lecturing with dynamic visual explanations is a promising path. Guided by multimodal design theory, real improvements in novice student's understanding of program dynamics can be obtained. Selander and Kress mean that the choices that each individual is making in a learning process can be looked upon as fixation points. A meaning and a basis for a potential continuation is then temporary locked. What is perceived as an interesting challenge and what catches the attention at a particular time, are two factors which, according to Selander and Kress depends upon what one chooses.

7 Future work

The analytics from the course for university teachers indicates that something in the second course made all of the participants engage earlier and deeper than in the previous course. Was it because of the progress bars, the badge or something else? This spring of 2015 there will be an interview study conducted with the course participants focusing on what makes them engage early in a course.

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Online Continuing Education for Health Professionals: Does Sticky Design Promote Practice-relevance?

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Abstract: Online continuing education (CE) holds promise as an effective method for rapid dissemination of emerging evidence-based practices in health care. Yet, the field of CE continues to develop and delivery is predominately face-to-face programs. Practice-oriented online educational methods and e-learning platforms are not fully utilized. Educational theorists suggest an experiential approach to CE consistent with adult learning theory. A compelling question remains: Can online asynchronous CE programming prepare health care providers in delivering higher-level practice competencies?. To address this question, the authors have identified seven composite “sticky” factors that have been critical to the engagement of learners and the creation and delivery of practice-oriented online educational programs (Zaghab et al, 2015). The sticky factors are based in knowledge management (Nonaka, 1994; Szulanski, 2002) and adult education or andragogy (Knowles, 1970; 1984). In this paper, sticky factors are mapped to Moore and colleagues’ (2009) higher level learning outcomes in health care CE. Data are presented on learner reported practice-related outcomes in a selection of online CE courses on the CIPS Knowledge Enterprise™ portal with the University of Maryland School of Pharmacy’s Center for Innovative Pharmacy Solutions (CIPS). A dynamic, adaptive e-learning environment built by technology partner, Connect for Education, Inc., provides the innovative platform and the Acclaim! interactive learning technology. This technology-instructional partnership is dedicated to an iterative continuous improvement process called the Learner Stewardship Cycle (Zaghab et al, 2015). The cycle improves stickiness and learner engagement in order to achieve higher-level learning outcomes in CE. Findings suggest that of the 769 learners successfully completing an online course with two or more sticky design segments, the majority report reaching level 4, 5 and 6 learning competencies. Learners from the professions of pharmacy, nursing, medicine, and other health decision makers also found the courses relevant, easy to use and evidence-based.

Keywords: Health Care Practitioner, continuing education, situated online learning, learner engagement, continuous improvement, and practitioner-learner

1 Background – Challenges in online continuing education

While emerging options in the online delivery of education have expanded exponentially in the last decade, health care continuing education (CE) offerings have not kept pace with the capabilities offered (Furman & Sibthorp, 2013). Health care is a rapidly changing field driven by the extraordinary pace of scientific discovery and CE is an important way that health professionals are “updated” with the latest knowledge and skills. New scientific discoveries often require changes in clinical practices. However, practice is slow to change (Ferlie et al, 2005) and CE professionals are stepping into this gap. Pressure is mounting to expand the use of dynamic online platforms for CE to meet health professional needs (ACEHp, 2015).

Online asynchronous programs allow for standardized, geographically dispersed learner enrollment anytime and anywhere without cost of travel. When compared to live programming, online CE is an accessible, convenient, and often cost-effective alternative. Asynchronous CE is also a viable option to disseminate new evidence and best practices to a broad audience of health professionals.

A global meta-analysis conducted by Cook and colleagues (2009) compared the effectiveness of 201 online CE programs to live programs to find no significant difference in the effectiveness of online versus face-to-face CE in achieving the stated learning outcomes. This meta-analysis compared learner outcomes in internet and

face-to-face delivered CE programs over a 17 year period of time. However, the study did underscore the variation in the quality of the CE programming.

Even in agencies charged with practice dissemination, e-learning technologies are not fully utilized. One example of this is the CE programs offered by the Effective Healthcare Program of the U.S. Agency for Healthcare Research Quality, the agency responsible for dissemination of evidence-based practice change (http://effectivehealthcare.ahrq.gov/tools-and-resources/cmece-activities/). The Effective Healthcare Program offers a total of 41 continuing education modules targeting physicians (41), pharmacists (14), nurses (14), nurse practitioners (14), case managers (14) and health educators (6). The educational strategies for AHRQ’s CE offerings included readings from medical publications, visual (not audio) slide presentations, and multiple choice post-tests. Three of the 41 modules were playback webinars (7.3%) and eight (19.5%) programs had playback audiovisual. None of the 41 modules on dissemination of best practices in effective health care were interactive. Six workshops were delivered face-to-face in locations across the U.S.

2 Measuring health practitioners’ needs as learners

The learning orientation of health care practitioners presents particular challenges for asynchronous online CE programming. Practice, by definition, is a series of interconnected behaviors including: “forms of bodily activities, forms of mental activities, “things” [tools and artifacts] in their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge.” (Reckwitz, 2002, p. 249). In short, practitioners require practice in order to learn to practice.

Moore, Green and Gallis (2009) built and have improved a widely accepted framework for the measurement of CE program success in achieving practice-oriented outcomes for health professionals. In their framework, learning for practice is connected to “doing”. Thus, effective CE programs should transmit actionable knowledge and provide a forum for learners to demonstrate physical competencies. Table 1 summarizes the outcomes to be measured in health care CE programming. These outcomes serve as metrics for the CE activity evaluations reviewed in this paper.

When designing online programs, quality factors for experiential CE point to the learning outcomes framework proposed by Moore, Green, and Gallis (2009). The learning outcomes for medical practitioners, argued Moore, must extend beyond declarative or domain knowledge to include process-type knowledge such as adhering to clinical practice guidelines when treating patients. Ultimately, practitioners must demonstrate competency (level 4) and the ability to perform patient care in an authentic setting (level 5). In addition to command over domain knowledge, Levels 5 and 6 CE learning outcomes involve mobilization of embodied knowledge. Learner simulation of practice skill in a trial-and-error setting is important for practitioner-learners to ultimately achieve these learning outcomes online.

Health care is not the only field where learning is experiential. Adult learning theorists endorse educational methods with relevant, actionable knowledge for all adult learners (Knowles, 1984). Adults who are rich in practice experience must have opportunities to demonstrate the application of learning to authentic work settings.

As noted in an earlier publication (Zaghab et al, 2015), many learning management systems and online learning environments (Hassanzadeh et al, 2012; Wang, Want & Shee, 2007; Liu, 2014) fail to measure the engagement of the learner, and the inclusion of situated, contextual learning, active learning components, and authentic learning environments. Table 3 identifies program design factors from the literature and shares implications for online engaged learning. Online CE can be designed with higher level learning competencies as the desired outcomes. Design factors can be, and in the study today, are, integrated into program design to meet the CE needs of adult practitioners.
Table 1: Literature on experiential education: Implications for educational program design excerpted from (Zaghab et al, 2015)

<table>
<thead>
<tr>
<th>Source</th>
<th>Educational factors identified</th>
<th>Implications for course design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martz &amp; Shepherd (2003)</td>
<td>Demonstration of skill is required. Course design must address not only changes in content or domain knowledge, it must address behaviors associated with practice change.</td>
<td>Active learning exercises encourage practice. Hands-on practice demonstrates competency.</td>
</tr>
<tr>
<td>Herrington &amp; Oliver (2000)</td>
<td>Authentic learning environments are essential for practitioners. Learning and the context of learning cannot be separated. Knowledge must be &quot;relevant to solve problems&quot;--not to memorize facts. Praxis creates actionable knowledge for practice.</td>
<td>Learning environments simulate authentic settings for professional practice and provide evidence-based tools for clinical decision-making.</td>
</tr>
<tr>
<td>Brown, Collins &amp; Duguid (1989)</td>
<td>Practitioners learn in a way that will prepare them for complexity and performance in real life.</td>
<td>Complex case studies and real-life challenges are opportunities for critical thinking and translation of knowledge into practice. Feedback on case work is formative.</td>
</tr>
<tr>
<td>Moore, Green &amp; Gallis (2009)</td>
<td>Techniques to reinforce learning include: a) creating and reinforcing a learning experience as a &quot;teachable moment&quot;; b) enabling practitioner-learners to utilize critical thinking and reasoning in treatment decisions; c) structuring an experience to elicit learner’s commitment to improving competency; and d) providing formative feedback to learners.</td>
<td>Utilize experts to testify, provide relevance, and model behavior prior to learner demonstration.</td>
</tr>
<tr>
<td>Osman &amp; Hannafin (1992)</td>
<td>Metacognition or self-assessment by learners is an ongoing process to improve practice. Learners interpret and generate inferences. Reflection facilitates meta-learning.</td>
<td>Reflection exercises relate to the performance or practice exercises by learners or peers.</td>
</tr>
</tbody>
</table>

3 Structure and purpose of the paper

This paper will review the factors in experiential learning for health care professionals. Next the authors will apply these factors to online learning environment in light of Moore, Green and Galli’s long-standing framework for CE competencies. Sticky aspects of e-learning environment will be described with regard for how to address the unique challenges of designing and delivering practice-oriented online CE for health professionals. The setting for the study will be described. Program evaluation data from 769 CE learners and 87 sticky course learners will report descriptive learning outcomes according to Moore’s framework. The learners’ perceived outcomes and competencies are noted. Findings will be discussed and limitations will be noted.

4 Research question and definitions

The question to be addressed in this research is: When e-learning design factors are optimized in evidence-based online CE programs, can health care practitioners consistently achieve high levels of learning outcomes?

Knowledge is extremely useful in informing clinical practice, the CIPS Knowledge Enterprise philosophy aligns with Moore and company regarding the importance of an evidence-based transfer of knowledge and also the importance of integrating such evidence into embodied knowledge for clinical action demonstrated in Moore’s levels 4, 5 and 6.
Table 2: “Sticky” online program design and delivery based on Moore’s CE outcome levels (Adapted from Zaghab et al, 2015)

Moore and colleagues’ framework on the levels of continuing education outcomes has been widely accepted and serves as the basis for our approach. The framework was developed primarily for medical education but has been applied broadly to the health professionals (AChEP, 2015). Moore’s framework includes:

- Level 1 tallies nothing more than participation or attendance.
- Level 2 notes learner satisfaction.
- Level 3 focuses on the learner expectations and the level to which the course meets or exceeds those expectations. Level 3 includes two types of knowledge: a) declarative knowledge or ability to recall facts; and b) the learners’ ability to restate how to do what the CE activity intended.
- Level 4 examines competencies gained by the learner through the CE experience, specifically how to demonstrate in an educational setting the knowledge transmitted in the CE activity.
- Level 5 targets the learner’s ability to translate the knowledge or skill into the performance of practice.
- Level 6 reaches the patient experience and seeks benefit to the patient’s condition as a result of the health practitioner’s action.
- Level 7 is the degree to which the health status of the community changes.

The focus of this paper is on Levels 4 (Competence), 5 (Performance) and 6 (Patient Health Outcomes).

The paper links sticky factors in module design in the e-learning environment with the learner reported achievement of these levels.

The term “sticky” utilized in Table 2 is borrowed from Szulanski (2000), who coined the term and articulated the challenges of transferring tacit knowledge between individuals in the workplace. His research substantiates that “knowing in practice” is the most difficult kind of knowledge to transfer. In this paper, tacit knowledge is known as embodied knowledge or knowledge that is held in experience. Examples include: how to give an injection, conduct an ultrasound, and perform a surgical procedure.

The term “sticky” is borrowed from Szulanski. Szulanski’s (1994) research found that tacit knowledge “sticks” to the owner and rejects transfer unless it is accompanied by embodied experiences. Since early research in knowledge transfer, innovative educators have shed light on situated learning and practice-based learning as noted in Table 2. The literature delineates desirable instructional factors in situated learning (Martz & Shepherd 2003; Moore et al 2009). This work extends and organizes these factors into educational elements necessary for design, delivery and evaluation of experiential learning in online learning environments.
Measures and methodology

This real-world investigation examines learner-reported learning outcomes in a total of 769 CE activity evaluations submitted by learners enrolled in the CIPS Knowledge Enterprise portal between November 2012 and October 2015. Electronic surveys via Survey Monkey were administered to learners immediately following successful completion of each course. Course instructors were blinded as to the learner's completion and responses. Completion rate of the survey was 100% for health professionals seeking CE credit because the activity evaluation was required to receive CE credit. Courses were certified for pharmacist, pharmacy technician, physician, and school nurse participation, and more recently physicians. Two hybrid courses had a final course component by phone or face-to-face.

The activity evaluations maintained consistent elements for reasons of certification but varied according to the learning outcomes of the modules. Two forms of Likert Scale questions (four point and five point scales) were used and these variations are noted in the analysis. Four point Likert questions were adjusted with zero for neutral in calculating a mean score. Only one survey response was allowed per learner and no identifiable learner information was used. Thus, learners may have participated in one or more courses, a matter not considered in this analysis. It may have influenced the learner's cumulative competencies--an area for future research.

The course mix totaled 87 CE hours involving 24 courses. Of these courses 19 included active learning exercises, 20 involved multimedia, 6 practiced active self-assessment, 7 provided real-world tasks and cases, 14 required skills practice, 12 guided learners in role reflection, 4 involved practice coaching, and 15 involved real-world assessments.

Online courses selected for this analysis include two or more segments with sticky design factors CE activities ranging from 1-20.5 hours of credit. Courses, series of courses, and practice certificate programs were selected based on the factors in Table 2. Qualifying design factors included practice activities, interactive problem-based learning, hands-on skills practice, practice skill demonstrations with stakeholders, either assessments or practice using real-world cases, self-assessment through reflection, and application of actionable knowledge such as clinical guidelines to complex clinical examples. In certificate programs and a handful of skill-based online courses, e-learning technologies have enabled individualized skill demonstration and individualized coaching.

Each CIPS Knowledge Enterprise course (module) is comprised of many segments combined to achieve the application and practice-based learning objectives. Components include but are not limited to the design factors in Table 3: a) instructional materials; b) faculty introductions, disclosures; c) learning objectives and description of the larger series or certificate; d) testimonials from experts in the field as well as practitioners on the application; e) multimedia knowledge-based instruction (also referred to as micro-lectures); f) correct and incorrect video demonstrations of practice activity; g) active learning complete with interactive question and answers as well as discussion; g) professional self-reflection; h) hands on demonstrations of learners for skills practice; i) complex case studies including patient videos, medical charts for practitioner intervention; and j) case studies requiring the application of clinical guidance.

Each online course consists of artful rather than prescribed combination of possible segments. Modules vary in how sticky segments are designed and combined to achieve the learning outcomes. Only courses with two or more segments with sticky designs were included in the study.

The theoretical perspective

The authors adopt a social constructivist epistemology of teaching and learning (Palincsar, 1998) in this examination of learning outcomes and course design. The sticky design and related technologies when combined act as the mediator between learner and the e-learning environment. This is similar to the dominant role the instructor plays in a face-to-face classroom. Thus, sticky design is considered by the authors, to be a compelling theoretical factor in how e-learning can achieve practice-related competencies in online learners.
7 The setting

Since 2011, the University of Maryland School of Pharmacy’s CIPS and Connect for Education, Inc. (C4E) have collaborated in a university-technology partnership. The CIPS Knowledge Enterprise™ (www.pharmacists4knowledge.org) is a mobile-accessible, asynchronous, continuing education portal for practicing health professionals. The CIPS Knowledge Enterprise uses a quality improvement approach termed the Learning Stewardship Cycle (LSC) (Zaghab et al, 2015), a step-by-step process of micro-improvement to improve the stickiness of the online program based on data provided by the e-learning environment. The LSC micro-improvements aim to optimize stickiness and learner engagement for the practitioner-learner in the online asynchronous classroom.

The portal offers e-commerce services including registration, payment, and certification history for learners. Since its inception the portal has offered over 550 continuing education hours, many practice series, and four practice-based certificate programs with additional practice certificates planned. Enrollments have been concentrated regionally, but numbers include learners from across the globe, including physicians, pharmacists, school nurses, pharmacy students, pharmacy technicians, and health decision-makers. Working side-by-side with content experts, the CIPS-C4E team plans and shapes segments carefully to ensure that content is optimized through the use of sticky factors in design. Higher level learning outcomes require more rigorous educational plans. One powerful capability offered in the e-learning environment is Acclaim™, a virtual simulator. The CIPS Knowledge Enterprise provides individualized coaching in the form of formative feedback via Acclaim!

CIPS Knowledge Enterprise online CE courses are created from building blocks or “segments” which range in length from 15 seconds to 15 minutes. Segments include: expert testimonials, program mapping, audiovisual didactic presentations, interactive inquiries, self-reflection, learner feedback on exercises, regular learner reinforcements, active learning exercises, audiovisual case studies, skill demonstrations, practice skill exercises, scaffold case video scenarios, mailed inhaler placebo devices, videotape help tools, instructor coaching and feedback session, hands-on video simulation (assessment), and knowledge-based assessment, among others. Educational programs range from one to over 20 hours. As the length of the program grows, so does the importance of improved stickiness in design.

8 Findings

Drawing from a sample of 769 learners in sticky designed courses, the findings in this section suggest patterns and emerging trends in the relationship between sticky design and learner reported level 4, 5 and 6 outcomes. This section will provide a summary of CE offerings in the form of practice certificates (15 or more hours), series (multiple modules focused on application of skills), and course offerings with two or more sticky factors integrated into the design. Given the importance of academic integrity, learner reports of the evidence basis and credibility of the course is provided. Differences among health care professionals are noted. Next the learner reported competencies and outcomes will be presented.

Balance, objectivity, and a current base of scientific evidence are all foundational elements in any certified continuing educational course for health professionals. Table 3 presents learner perceptions of course credibility, accessibility, and overall satisfaction. The mean responses are aggregated for both 4 and 5 point Likert questions for all sticky courses.

Table 3: Learner Perceptions of Module Integrity and Academic Credibility
The mean score for credibility was 4.4; for objectivity a mean of 4.5; and a mean of 3.8 was reported. Learners indicated agreement and strong agreement for ease of use (4.3 and 3.7) and overall satisfaction with the online CE course (4.3). As noted in the methods, the post-course surveys varied slightly which accounts for the differences in numbers.

Physician satisfaction, in general, ranked the e-learning environment ranked lower (mean 3.6) than nurses/pharmacists (mean 4.5) and pharmacists alone (mean 4.4). Other health professionals and decision makers ranked the e-learning environment as 3.9 which indicated a slant toward agreement but some level of neutrality.

Table 4: Appropriateness of e-learning environment as ranked by profession

<table>
<thead>
<tr>
<th>Professional Affiliation</th>
<th>N</th>
<th>Mean¹</th>
<th>Mean²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacists</td>
<td>446</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>Nurses and pharmacists</td>
<td>144</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>Physicians</td>
<td>18</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Healthcare Decision-Makers</td>
<td>75</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>Question Not Asked</td>
<td>86</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>769</td>
<td>4.3</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Learner reported benefits from the sticky courses are broken down by number and percent of respondents in each Likert measure. Level 6 learning outcomes were not achieved by every learner. Ninety-seven point seven of 679 respondents reported the competencies and skills from the course will impact their patients positively. Only 2.7% disagreed. A similar impact was reported by 635 learners where 96.8% agreed that the course improved their clinical service delivery. Only 3.3% reported disagreement or strong disagreement with a perceived impact on their clinical practice. While 1.3% of the learners disagreed and did not feel more confident in applying learning to problem decisions in their authentic work environment, 94.7% reported agreed or strongly agreed that they felt more confident after the online training.

A similar pattern is found in level 5 learning outcomes where 92% of 567 learners agreed or strongly agreed that the case studies had practice-relevant application. This question is unique in that it directly associates a single sticky course design element to a specific learning outcome. Level 4 learning outcomes are also essential to the learner-practitioner’s experience. In a cohort of 75 hybrid course learners, 93.3% found the course design and concepts applied to real decisions.

Learners were asked to rate the appropriateness of the online environment for practice-based CE. There were notable differences between professions. The physician ratings ranked between agree and neutral (3.58) with only 15 learners reporting. Decision makers (mean 3.93) included physicians, consultants, nurses, and non-pharmacists. Whereas, pharmacists and mixed cohorts of nurses and pharmacists ranked higher with a mean of 4.36 and 4.57, respectively.

In a longitudinal study of an interprofessional cohort of health decision-makers, Pickering and colleagues (Pickering et al, 2015) found that learners in the practice certificate rated real-world decision making as 4.04 mean, in the hybrid program in comparative effectiveness research. Learners felt confident of their abilities to impact real work decision-making and to solve problems in their authentic work setting-- both indicators of Moore’s Levels 5 and 6 competencies.
Table 5: Sticky courses and learner reported ability to achieve Moore’s Level 4, 5 and 6 CE learning outcomes

<table>
<thead>
<tr>
<th>Learner Self-Reported Benefit</th>
<th>Total N</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>No Opinion</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>My patients will benefit from my new knowledge gained from the training. (Level 6)</td>
<td>676</td>
<td>5</td>
<td>0.7%</td>
<td>9</td>
<td>1.3%</td>
<td>0</td>
</tr>
<tr>
<td>The case studies and interactive exercises helped me to apply the information provided. (Level 5)</td>
<td>567</td>
<td>7</td>
<td>1.2%</td>
<td>36</td>
<td>6.4%</td>
<td>2</td>
</tr>
<tr>
<td>The program will help me better deliver high quality clinical services. (Level 6)</td>
<td>635</td>
<td>3</td>
<td>0.5%</td>
<td>18</td>
<td>2.8%</td>
<td>0</td>
</tr>
<tr>
<td>The course design and materials showed how course concepts could be applied to real decision problems. (Level 4)</td>
<td>75</td>
<td>0</td>
<td>0%</td>
<td>5</td>
<td>6.7%</td>
<td>4</td>
</tr>
<tr>
<td>I feel more confident in my ability to provide valuable input...into problem decisions in my work setting. (Level 6)</td>
<td>75</td>
<td>0</td>
<td>0%</td>
<td>1</td>
<td>1.3%</td>
<td>3</td>
</tr>
</tbody>
</table>

9 Conclusion and Study Limitations

This paper is the first step in exploring the complex interrelationship of higher-level learning outcomes in CE and sticky course design. Research into sticky factors can become more robust in a number of ways. Benchmarking learner progress is a challenging task, especially for level 5 and 6 outcomes. In the future, in order to adequately determine how the CE course has changed practice, we must first assess the status of the learner as well as a sense of their practice environment. A pre-course self-report of practice setting could be considered.

To provide needed power for statistical analysis, standardization of the five point Likert scale in activity evaluations is necessary and already underway. The differences between health professionals can be better assessed within the same course, series, or certificate and is another area for future research. With a larger sample size, each specific sticky factor could be analyzed separately to determine its effectiveness in achieving level 4, 5 and 6 learning outcomes. From the continuous improvements and micro-changes discussed in the Learning Stewardship Cycle, CIPS Knowledge Enterprise courses create a unique set of challenges. Continuous improvement suggests that the course at the beginning may not have been as “sticky” as the same course evaluated at the end of the period under study.

Cognizant of the limitations, the authors conclude that the vast majority of the CE learners reported practice-relevant outcomes which will benefit their patients, their practice or their decision-making abilities. This meaningful contribution may open doors for sticky e-learning as a method for widespread dissemination of practice-relevant CE for health professionals. Public, private and governmental units dedicated to
dissemination of best practices should critically assess the design and delivery of their CE programs with the sticky factors in mind.

Sticky factors in e-learning course design are concepts in need of additional definition. The authors urge the development of new metrics and the validation of metrics for each sticky factor in online course design. Once validated, new metrics could serve as a source of guidance for any CE provider who sets sights on optimizing the stickiness of their CE programs.

References


