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Strategies and Methods for Creating an Educational Computer Game that Teaches Idioms

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Abstract
This paper will outline the key educational design features of a particular computer game, Idiomatico, that teaches idioms. The paper aims to give insight into some of the reasoning behind the features chosen for the game, and how this is intended to improve the learning experience.
Introduction

Idioms are a type of multiword construction. They are also lexemes because the set of words in an idiom form a semantic word. A particular problem with idioms is that the individual words comprising the idiomatic phrase cannot be interpreted literally, so it is unlikely that the meaning can be guessed. Instead, the metaphorical meanings of idioms must be learned. This process can be aided by an understanding of the conceptual basis that it originates from (Holme 2009). It important to learn idioms because they often have a stronger meaning than literal words (Cambridge Idioms Dictionary, 2006).

Idioms are low-frequency in nature, and are estimated to belong in the 5000-7000 word level for upper-intermediate to advanced learners. Since they occur infrequently, idiomatic phrases are unlikely to be learned incidentally and need to have conscious or explicit attention placed upon their acquisition (McCarthy, O’Keefe, & Walsh 2010). The computer game in the study, Idiomatico, is an attempt to support this process of learning. The aim of Idiomatico was to expose learners to idioms, expose learners to possible similarities contrasts between their own L1 metaphorical associations and English metaphorical associations increase player’s self-awareness of their own knowledge and recall processes, and motivate learners. These will be explained under their relevant sections later in this paper. First, there will be a brief explanation of the gameplay.

Idiomatico overview

The gaming action of the Idiomatico game is as follows. The learner is presented with a sentence that uses an idiom, and they must choose from three possible answers. When they make a selection, they are asked to rate how certain they are (i.e. not sure, pretty sure, definite). If a player chooses the ‘definite’ option and they are right, the
idiom is removed from their database until there are no idioms left in the game for
them. The students are also given a score which depends on their certainty level and if
they were correct or not. There are over 500 idioms in the database, and since the
game was first designed for nursing students, these idioms all relate to body parts or
health idioms – note that about 1/6th of all idioms refer to the body (Kovecses 2001).
There are a number of avatars available in the game, and players have access to
instructions, tips, and a score leader board.

Game design features that increase exposure to idioms

Any game which deals with idioms will provide some form of exposure. However, the
nature of the exposure is important. In the case of Idiomatico, exposure is gained
through both spoken and written input. The spoken input is provided by native
English speakers of different ages and gender. The speaker was randomly allocated,
so the learner does not know what type of speaker they might hear for each sentence.
Furthermore, the idiom is said before it is displayed in text on the screen, providing an
opportunity to concentrate on the spoken form and compare this to the written form. It
is intended that the learner has the opportunity to hear prosodic information, such as
where the word stress might be placed. The written input involves presenting the
idiom as a part of a whole sentence. It is not presented like it was a dictionary entry,
which is quite artificial. While presenting the idiom within a sentence means that
some of the technical information is lost, it provides a contextualised example of the
idiom in use. Furthermore, in keeping with the avoidance of formal dictionary entries,
the possible answers offered to the learner are also in sentence form. Within the
sentences, the simplest words are selected over their more complex synonyms, since
unknown vocabulary could detract attention from the focal idiom.

Game design features that give exposure metaphorical L1 and L2 similarities
and contrasts

A key element in the Idiomatico game lies in the process of how wrong answers are
formulated. It is relatively easy to give correct answers, but the formation of highly
distracting incorrect answers is very difficult. This task is even more difficult when
the question-writer is steeped in one culture and has no long-term immersion
experience of other cultures. Sometimes misunderstanding of an idiom might stem
from a literal interpretation of a single word within that idiom. However, it is just as
likely that misunderstanding of idioms occurs because the things being referred to in
the L2 do not have the same associations in the L1. Idioms are essentially metaphors
that capture a cultural worldview. Therefore, it was decided that the wrong answers
needed to be generated from a range of responses given by target students from China,
Japan, and Korea (who comprise most of the international students in the school that
created the game). These students also had to be at a stage of language skill just
below that of the target cohort, because their interpretations would tap into any
lingering problems that were being seen at a higher level. Thus, a group of learners
were hired to make guesses at the meaning of each idiom, and they were encouraged
to translate the words back into their own language to make sure that guess was
formed from their L1 cultural understanding (as much as possible). Note that this
process could also be achieved by collecting a bank of wrong answers from students
doing an idioms test, but this facility was unavailable to the school making the game.
After collating the right and wrong answers, they were refined into a format suitable for the game. The intention was to highlight the contrasts between the L1 and L2 metaphorical conceptualisations, albeit in a generalised way because some answers (e.g. Chinese-sourced) would appeal to particular learners (e.g. Chinese learners) over others (e.g. Japanese learners). If the game was coupled with classroom teaching about general cultural associations about the idiom categories of the game, it would enhance learning greatly.

**Game design features that increase player’s self-awareness**

The use of certainty-based marking increases a learner’s declarative knowledge for idioms. The certainty-based marking in this game gives 50, 100, or 150 points to correct answers, depending on whether the learner rated their certainty as not sure, pretty sure, or definitely. If the learner’s answer is incorrect, they lose 0, 100, or 300 points, also depending on how they rated their certainty. At the point when the learner chooses their certainty level, there is no time limit. They can review their choice more carefully while making that decision. This gives them thinking time which is meant to improve self-awareness. By reviewing what they know, how they know it, and elaborate on this, they can develop theories about what they have learned and how they remember it. The more effort a learner puts into learning a new item’s meaning, the more likely they are to remember it (Godwin-Jones 2014). Better learning occurs when effort is put into both trying to learn what something means and then how you remember it later: students must “relate new information to what they already know, organize it, and regularly check their comprehension” (Bruning, Schraw, & Norby, 2011, p. 6). In a way, this process is similar to teaching, where you have to think through the process and explain what you know, except that the learner explains to themselves.
Game design features that motivate learners

One motivating factor for students to interact with the idiom content is the game’s use of a time limit on choosing an answer. Placing a time limit on solving a problem encourages better learning (Chappelle 2001). The second motivating factor is the use of a scoring system and a scoreboard. Learners like to improve against their own high scores, and some are very motivated to beat the high scores of others. Scores give a student a goal to aim for – one that is more tangible than an abstract increase in vocabulary knowledge. It can encourage discussion, research, and focused learning about idioms outside of the game, because learners will see it as a means to getting a better score and more prestige.

Another motivating factor in the game is the use of avatars. In this case, there is a small selection of avatars that represent gender and ethnicity. Since the game is designed for nursing students, the avatars all wear the standard nursing uniform for their school. This helps them identify with the avatar and connect with the game. Watching and manipulating the avatar helps make them think about how others view them and how they might control their own actions. The other factor designed into the game is the range of emotional reactions given by the avatars. They look like they are seriously thinking when an answer is needed, cheer when they get an answer correct, and cry when they get an answer wrong. This emotional involvement has been shown to affect the learner, motivating them to get correct answers (Müller and Habel 2012).

The gameshow host in *Idiomatico* also has a range of responses too, but these are in response to the avatar. The game also has a number of sounds which play at different stages of the game, such as a ticking clock sound when selecting an answer, an applauding audience if a correct answer is given, and pleasant interlude music.
Conclusion

The paper explained a number of the features that comprise *Idiomatico* and it should be clear that when a videogame is created, there are many opportunities to value-add to the educational possibilities. As explained, this game was created with a number of important features in mind. These included the use of audio input and feedback using different voices and sounds, the use of realistic sentences and distractor answers, the questioning of the learner’s certainty levels, the display of a range of emotional responses in an avatar which was designed to elicit empathy and identification, and finally giving a score and scoreboard for everyone to see. Creating an educational game is much more than just thinking about the gaming action. There are many opportunities to refine a game to ensure that learners are both motivated to learn and have the sufficient input to improve their knowledge. Hopefully, this paper has given some insight into one way this might be achieved.
References


Enhancing Vocabulary Learning through Pictures by E-mails

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Abstract
This paper reports on the study of students' vocabulary learning through pictures by e-mails and their attitudes towards their learning. Seventy-two fourth year students of English for International Communication major studied in a five week vocabulary learning enhancement activity. Each student had two jobs to do in the process of learning vocabulary. One, the student independently accessed their e-mails to send a picture to the same classmate each week for 5 weeks, check the words in their own pictures sent back by his or her classmate. Two, the student himself or herself had to find words sent by his or her classmate’s pictures every week for 5 weeks and write back to him or her for checking via e-mail. The students answered the questionnaire on vocabulary they learned and their attitudes towards learning vocabulary through pictures by e-mails in the sixth week. Quantitative and qualitative data were collected by means of the questionnaires. Descriptive results were analysed for percentages, frequency, and mean. Findings were: more than 85% of participants agreed or strongly agreed that the pictures were interesting and they learned the meanings of new words. The words as nouns were mostly chosen in describing the pictures while adverbs were rarely used. 65.28% of the students agreed that E-mail was a suitable tool for learning vocabulary. The benefits they got were learning new words in both their parts of speech and meanings. The problems they faced were they thought there were not enough words to get from the pictures.

Keywords: Enhance, E-mail, Picture, Vocabulary
Introduction
According to the researcher's experience, when teaching Advanced Reading to fourth year students of the English for International Communication program, vocabulary is the first step in foreign language learning. The difficulty of teaching this subject is that students find themselves not knowing many words in the texts even some words are common words. That is the reason why they do not understand what sentences of text are about. It is because they do not know the meaning of most words in a sentence or a text. Although the teacher allows students to use a dictionary when they study, students forget the meaning easily. They learn vocabulary through pictures by themselves outside class by using e-mail as a tool to send pictures among themselves. The students need to be inspired to learn vocabulary from pictures. As the old saying goes, A picture is worth a thousand words. The researcher thought that using this kind of method would enhance students' learning vocabulary by themselves through pictures by e-mail. Pictures could be a suitable alternative to improve students’ vocabulary achievement. Pictures can be used as a media to transfer an image of the real thing. As we know, that teaching through pictures is both effective and practical. Besides, technology is very useful for students to learn vocabulary. Therefore e-mail was chosen to be a tool for the students to learn vocabulary.

Thailand is currently a member of the ASEAN Community and with the establishment of the ASEAN Community in 2015 it will inevitably affect Thailand in every aspect. To ensure that Thailand is prepared to be an active and contributing participant of ASEAN, the Office of Higher Education Commission (OHEC) launched the Higher Education Strategies for the ASEAN Community in 2015. The goal of the strategies is for Thai graduates to be equipped with professional skills, communication skills, and inter-cultural skills that meet international standards. One aspect of the strategy is the reform of language education in English and other languages used in ASEAN.

Currently Thailand already as a member of the Asian Community in 2015, English becomes a much more important tool for communication among people of the 10 countries in South East Asia than before. At the tertiary level, English is a required subject for all majors. However, in some universities such as Rajamanagala University of Technology Srivijaya, Songkhla, Thailand, they still need English, especially vocabulary which students lack. This results in a lack of English ability to communicate with foreigners in the Asian community. It is therefore a challenge for teachers of courses such as Advanced Reading to improve students’ vocabulary for them to apply in the 4 skills: reading, writing, listening and speaking.

Purpose of the Study
1. To investigate whether pictures by e-mail can improve students' vocabulary learning.
2. To find out what attitudes the students have towards learning vocabulary through pictures by e-mail.

Context of the Study
The participants consisted of 72 fourth year students majoring in English for International Communication who studied the Advanced Reading course with the researcher in the first semester of the academic year 2014 at Rajamangala University of Technology Srivijaya, Songkhla. Participants were instructed to access their e-mail
to send pictures to classmates, check words in their own pictures sent by classmates
and find words in friends' pictures and write back to them by e-mail.

Reviewed Literature
Vocabulary and Picture
Vocabulary is generally the total number of words that exist in a particular language. Moreover specially, it functions as the foundation stone without which any language is impossible to exist in this world. Vocabulary is acquired incidentally through indirect exposure to word and intentionally through explicit instruction in specific word-learning strategies. (Linda Diamond and Linda Gutlohn 2006). Learning a Foreign language, especially English as a language of international communication throughout the world.

Vocabulary is one important part in learning a language, because without vocabulary it is difficult to communicate with each other. Harmer (1993:153) says that if language structure makes up the skeleton of language, it is vocabulary that provides the vital organs and flesh. Based on the expert statements above, it can be inferred that vocabulary is a very essential part in learning languages. By knowing vocabulary people understand other and it makes expressing an idea easy. Visual aids are usually used to help teachers to deal with a task on actuating the teaching materials. The aids which are used must suit the aim and the setting of the teaching learning process. Stevick (1957:74) defines that visual aids are anything visible which helps students learn a language more quickly and more accurately. Thornsbury (2004) advises to visualize a picture for a new word or to link an abstract word with some mental image Images drawn by students themselves have the best outcomes. Besides, imaging, there are other mnemonics, such as making clues from associations with similarly sounding words and its meaning in the mother tongue. Thornsbury (2004) also claims that students' own images have the best influence on remembering.

A picture is a kind of visual aid that can help students in acquiring vocabulary. There are some advantages and disadvantages of using pictures in teaching English. Hill (1990: 1) listed several advantages of pictures, such as availability (one can get them in any magazines, on the Internet etc). A picture can be used for an individual student or a group. Pictures meet with a wide range of use not only in acquiring vocabulary, but also in many other aspects of foreign language teaching. Wright(1990: 4-6) demonstrated the fact where he used one complied picture and illustrated the possibility of the use of five very different language areas. He showed employing pictures in teaching structure, vocabulary, functions, situations and all four skills. And some of the disadvantages are: It is difficult to look for a specific picture which is suitable for the students' level, curriculum, needs or socialization. However, "pictures have their limitations too". (McCarthy 1992: 115) For example in teaching vocabulary, pictures are not suitable or sufficient for demonstrating the meaning all words (McCarthy 1992: 115; Thornbury 2004: 81). It is hard to illustrate the meaning of some words, especially the abstract ones such as 'opinion' or 'impact'. Therefore, not all vocabularies can be taught by picture, especially those concerning abstract concepts.

A review of the very large body of research related to the teaching and learning of vocabulary indicates that there are very strong reasons for implementing a systematic and principled approach to the teaching and subsequent learning of vocabulary as a
cornerstone for developing comprehension. Several researchers and vocabulary experts agree, vocabulary learning is really a special case of reading comprehension (Blachowicz and Ogle, 2001; Cunningham and Stanovich, 1998; Nagy and Anderson, 1984; McKeown, et al.,1983).

In addition, by implementing a systematic and principled approach to teaching and learning vocabulary, learners see vocabulary as a very important element in language learning and reading (Beck, McKeown, and Kucan, 2002; Bormuth, 1966; Davis, 1944, 1968). Receptive knowledge of words requires that the learner recognize a word and recall its meaning when it is met. Instructional techniques that help students become familiar with a large number of words are the best facilitators for this level of vocabulary learning and, because of this facilitation, can eventually lead to greater student reading comprehension (Beck, et al., 1987; Anderson and Freebody, 1981; Anderson and Kulhavy, 1972).

E-mail
Electronic mail, most commonly referred to as email or e-mail since ca. 1993, is a method of exchanging digital messages from an author to one or more recipients. Modern e-mail operates across the Internet or other computer networks. Some early email systems required that the author and the recipient both be online at the same time, in common with instant messaging. Today's email systems are based on a store-and-forward model. E-mail servers accept, forward, deliver, and store messages. Neither the users nor their computers are required to be online simultaneously; they need connect only briefly, typically to a mail server, for as long as it takes to send or receive messages. Historically, the term electronic mail was used generically for any electronic document transmission. For example, several writers in the early 1970s used the term to describe fax document transmission. As a result, it is difficult to find the first citation for the use of the term with the more specific meaning it has today.

Dictionary Use
Reference materials, primarily a dictionary, can be used in a receptive or a productive skill in language learning. However, since having insufficient time to consult a dictionary during the process of speaking and listening, more look-up work happens during reading and writing. A common situation is that, for example, when a learner meets an unknown word in the text and fails to infer the meaning through context, they might be advised to consult a dictionary. Looking up a word in a dictionary is “far from performing a purely mechanical operation” (Scholfield 1982, p.185); instead, a proficient dictionary user “is often required to formulate and pursue several hypotheses and make use of prior knowledge of various sorts, especially information derived from context” (Scholfield 1982, p.185). Except for locating the unknown word in the alphabetic list, which seems to be the skill most dealt with in respect of training dictionary use, other important facets involving effective dictionary use receive little attention (Scholfield 1982). Since many lexical items in a language have more than one meaning, learners should be instructed how to reduce multiple options by elimination. Scanning all of the definitions in the entry before deciding which is the one that fits is a good idea proposed by Underhill (1980). After choosing a seemingly reasonable sense from the definitions in the entry, a user then needs to “understand the definition and integrate it into the context where the unknown was met” (Scholfield 1982, p.190).
Research Methodology

Subjects
The population comprised of 72 fourth year students majoring in English for International Communication who studied the Advanced Reading course.

Instruments
The research instruments were two parts of questionnaires:
  Part 1: Students' attitudes towards learning vocabulary through pictures by e-mail.
  Part 2: Students' perceptions of the usefulness learning vocabulary through pictures by e-mail in an Advanced Reading course.

Data Collection
The first day of the Advanced Reading class, the teacher explained to 72 students what and how to do and learn vocabulary through pictures by e-mail.
The data collection process for this study included the procedures as follows.

Procedure
- Find and send a picture to his or her friend by e-mail once a week for five weeks.
- Find new words which the students have not known before or are unfamiliar with from the picture sent by a friend.
- Write down at least 10 words per picture in the e-mail. So there are at least 50 words all together for 5 pictures. Then send it back to the picture owner.
- The picture owner studies and checks the words sent whether they are proper words according to the picture and their spellings.
- Learning vocabulary through pictures by email is a pair activity so they do the activities with the same person until they have finished the activity.
- The number of words that the teacher wanted her students to learn were at least 100 words: 50 words from their own findings and another 50 words from their paired classmates.
- The students completed and submitted the questionnaire to determine students’ attitudes towards learning vocabulary through pictures by e-mail in the sixth week. The items used a 5 point Likert Scale format. All the items in the questionnaire given were explained and translated into Thai. The teacher collected the questionnaire.

Data Analysis
Data of the study was analyzed using descriptive statistics where frequency counts were tabulated and converted to percentages and mean.

Findings and Discussion
The recognition of the role of vocabulary in language learning has continued to grow in recent years. According to Neil Selwyn and Kate Robson (1998), most researchers and vocabulary experts believe that the best methodology employs both direct and indirect teaching and provides opportunities for both receptive and productive learning to occur.
Table 1: Students' attitudes towards learning vocabulary through pictures by e-mail.

<table>
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<tr>
<th></th>
<th>5 Strongly Agree %</th>
<th>4 Slightly Agree %</th>
<th>3 Neutral %</th>
<th>2 Slightly Disagree %</th>
<th>1 Strongly Disagree %</th>
<th>Total % (n=72)</th>
<th>Mean (X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The pictures are interesting.</td>
<td>31.94 (23)</td>
<td>55.56 (40)</td>
<td>12.50 (9)</td>
<td>0.00 (0)</td>
<td>0.00 (0)</td>
<td>100 (72)</td>
<td>4.19</td>
</tr>
<tr>
<td>2. I can find words to suit the pictures.</td>
<td>19.44 (14)</td>
<td>45.83 (33)</td>
<td>33.33 (24)</td>
<td>0.00 (0)</td>
<td>1.39 (1)</td>
<td>100 (72)</td>
<td>3.82</td>
</tr>
<tr>
<td>3. Finding out new vocabulary through pictures are challenging.</td>
<td>19.44 (14)</td>
<td>45.83 (33)</td>
<td>31.94 (23)</td>
<td>1.39 (1)</td>
<td>1.39 (1)</td>
<td>100 (72)</td>
<td>3.79</td>
</tr>
<tr>
<td>4. E-mail is a suitable tool for exchanging pictures.</td>
<td>23.61 (17)</td>
<td>45.83 (33)</td>
<td>22.22 (16)</td>
<td>5.56 (4)</td>
<td>2.78 (2)</td>
<td>100 (72)</td>
<td>3.82</td>
</tr>
<tr>
<td>5. E-mail is a suitable tool for learning vocabulary with friends.</td>
<td>16.67 (12)</td>
<td>48.61 (35)</td>
<td>27.78 (20)</td>
<td>4.17 (3)</td>
<td>2.78 (2)</td>
<td>100 (72)</td>
<td>3.72</td>
</tr>
<tr>
<td>6. I learn the meanings of new words.</td>
<td>37.50 (27)</td>
<td>48.61 (35)</td>
<td>12.50 (9)</td>
<td>1.39 (1)</td>
<td>0.00 (0)</td>
<td>100 (72)</td>
<td>4.22</td>
</tr>
<tr>
<td>7. I learn how to spell and pronounce the words.</td>
<td>18.06 (13)</td>
<td>50.00 (36)</td>
<td>30.56 (22)</td>
<td>1.39 (1)</td>
<td>0.00 (0)</td>
<td>100 (72)</td>
<td>3.85</td>
</tr>
</tbody>
</table>

Vocabulary is the one important part in learning a language, because without vocabulary it is difficult to communicate with each other. Harmer (1993:153) says that if language structure makes up the skeleton of language, it is vocabulary that provides the vital organs and flesh. Neil Selwyn and Kate Robson (1998) stated that using e-mail as a research tool potentially offers researchers many advantages such as easy access to world-wide samples, low administration costs (both financially and temporally) and its unobtrusiveness and 'friendliness' to respondents. 65.28% of the students agreed that e-mail was a suitable tool for learning vocabulary while only five or six participants disagreed that e-mail was a suitable tool for exchanging pictures and learning vocabulary with friends. However, e-mail's application as a research tool is constrained by its, as yet, limited and biased population of users in terms of age, income, gender and race (Neil Selwyn and Kate Robson,1998). E-mail might be no longer interesting as a tool for communication among students as before in 1993 and
there are other more popular tools such as Facebook (2004), Twitter (2006) Instagram (2010) or Line (2013). According to Sri Herawati, Ari Nurweni, Huzairin (2004), pictures could capture the students’ interest and stimulates students’ motivation and could be used for individuals or a group. More than 85% of the students agreed or strongly agreed that the pictures were interesting and they learned the meanings of new words. Stevick (1957: 74) defines that visual aids are anything visible which helps students to learn the language more quickly and more accurately.

Table 2: Number of new words learned by the students.

<table>
<thead>
<tr>
<th>No. new words</th>
<th>10</th>
<th>0</th>
<th>11</th>
<th>5</th>
<th>12</th>
<th>0</th>
<th>13</th>
<th>5</th>
<th>14</th>
<th>0</th>
<th>15</th>
<th>0</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. students</td>
<td>8</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>43</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Kinds of pictures chosen by the students.

<table>
<thead>
<tr>
<th>No. Pictures</th>
<th>people</th>
<th>places</th>
<th>things</th>
<th>others</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>110</td>
<td>175</td>
<td>51</td>
<td>24</td>
<td>360</td>
</tr>
</tbody>
</table>

Table 4: Kinds of parts of speech of words written by the students.

<table>
<thead>
<tr>
<th>Parts of Speech</th>
<th>Noun</th>
<th>Adjective</th>
<th>Verb</th>
<th>Adverb</th>
<th>Others</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. words</td>
<td>2,855</td>
<td>421</td>
<td>303</td>
<td>23</td>
<td>4</td>
<td>3,606</td>
</tr>
</tbody>
</table>

Table 5: Tools used by the students to find new words and their meanings

<table>
<thead>
<tr>
<th>Sources</th>
<th>Dictionary</th>
<th>Online Dictionary</th>
<th>Both Dictionary and Online Dictionary</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. students</td>
<td>4 (5.6%)</td>
<td>50 (69.44%)</td>
<td>18 (25.00%)</td>
</tr>
</tbody>
</table>

It was found that pictures of places were chosen mostly at 175 pictures, pictures of people were the second most popular among the students at 110 pictures while things were less interesting. As the saying goes, a picture paints a thousand words and pictures are a great way of improving English and pictures can be used to learn vocabulary. Surprisingly, 53 students or 73.61% of the students learned willingly more than 120 new words. Actually the number of words targeted by the teacher were 100 words. More than half of the students (43 out of 72 students) knew 120 words. Only 8 students studied 100 assigned words. Receptive knowledge of words requires that the learner recognize a word and recall its meaning when it is met. Instructional techniques that help students become familiar with a large number of words are the best facilitators for this level of vocabulary learning and, because of this facilitation, can eventually lead to greater student reading comprehension (Beck, et al., 1987; Anderson and Freebody, 1981; Anderson and Kulhavy, 1972). The researcher feels that this instruction technique could lead students to achieve reading
comprehension at a somewhat level and help them not to struggle when reading or spend too much time in finding words in the dictionary, which sometimes leads them to give up reading. Unexpectedly, 421 words were adjectives while 2,855 words were nouns in describing pictures.

All in all 97.22% accepted that they learned new words. A half of the students could not find new words for pictures in a dictionary, this problem was that there were not enough words to get from the pictures. It is difficult to look for a specific picture which is suitable for the students’ level, curriculum, needs or socialization. Not all vocabulary can be taught by pictures, especially those concerning abstract concepts (Sri Herawati, Ari Nurweni, Huzairin, 2004).

In order to find suitable words from the pictures, the participants used both online and book dictionaries because dictionaries are reference materials, primarily a dictionary which can be used in a receptive or a productive skill in language learning (Schofield, P., 1982, pp. 185-194). Therefore, 69.44% used an online dictionary to find new words, 25% used both a dictionary and an online dictionary and 5.6% looked up the words in the dictionary.

**Conclusion**
The researcher used e-mail as a tool for the fourth year students who studied an Advanced Reading course to learn vocabulary through pictures in order that they could surpass their lack of common vocabulary. It was found that more than 85% of the students agreed or strongly agreed that the pictures were interesting and they learned the meanings of new words. Only five or six participants disagreed that e-mail was a suitable tool for exchanging pictures and learning vocabulary with friends. Overall, more than 65% of the students agreed that they had a good attitude towards learning vocabulary through pictures by e-mail. Moreover, it was also found that 73.61% of the students learned new words of 120 words up more than the teacher assigned them to learn. Only 8 students studied 100 words assigned. The pictures of places were the most popular pictures among themselves while things were the least interesting. The students chose nouns mostly to describe the pictures while adverbs were rarely used. They preferred to look up words online rather than in a dictionary. Besides, 93.06% of the students searched for pictures from the Internet only. No one was interested to choose pictures from books and magazines. The benefits they got were learning new words in both their parts of speech and meanings. The problems they faced were they thought there were not enough words to get from the pictures. A few students found some new words were too difficult to remember and did not like the pictures sent from their paired classmates.

**Suggestion**
The researcher thought that pictures would be interesting for students to learn new words but some pictures selected by students did not contain enough words to learn. Therefore, the teacher should check all the students' pictures before allowing them to do the activities.
References


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‘Digital Natives’ Require Basic Digital Literacy Skills

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André Siebrits, University of the Western Cape, South Africa
Juliet Stoltenkamp, University of the Western Cape, South Africa

Abstract
This paper discusses a Digital Academic Literacy (DAL) Programme at the University of the Western Cape (UWC). It highlights the programme’s response to and alignment with emerging South African Higher Education (HE) national policy imperatives and discourses which include, the effective integration of ICTs for teaching-and-learning; and the need to increase and continue large-scale targeted work. This specific student development programme is deliberated within a paradoxical context, where on the one hand there are claims by Marc Prensky that the Digital Natives use of ICTs are significantly increased from their predecessors; and on the other hand, many of these Digital Natives still require basic digital literacy training and support.

The study highlights how gaining the necessary ICT support, better equips students to cope academically while, attaining skills which enhance employability. The researchers discuss the exponential growth of the DAL Programme, catering to first year students across departments, as well as the need for further expansion to accommodate all students who lack the necessary digital literacy skills to succeed at university.

A mixed-method approach is adopted, using both quantitative and qualitative evidence. Data was retrieved from the intranet of the Centre for Innovative Education and Communication Technologies (CIECT) as well as, via an internet-based online survey. Other data includes student assessment results after engagement in the DAL Programme as well as, contributions by field experts. Moreover, the researchers highlight the importance of critical change management processes to ensure the sustainability and quality of the programme.

Keywords: Marc Prensky, South African Higher Education, eLearning, Student Development.
1. Introduction

The paper explores Marc Prensky’s *Digital Natives* theory within a South African context and proves that the need for support programmes which educate incoming students on basic digital literacy skills is still needed at tertiary level.

Below the Digital Academic Literacy (DAL) Programme’s history is introduced.

1.1 DAL Programme History

A university wide task group formed in 1999 to investigate the delivery of computer literacy skills to novice users of digital media at The University of the Western Cape (UWC). This process resulted in the creation of the DAL and its formal acceptance as a credit bearing course, offered to all faculties at UWC where it is weighted up to 20% in a number of foundation courses. The DAL runs effectively as a result of staff who are dedicated to serving students and aiding them to succeed academically. The 2015 DAL team consists of one coordinator, six facilitators (three are full-time) and 31 tutors.

Since 2005, members of faculty have contacted the Centre for Innovative Education and Communication Technologies (CIECT) about implementing the DAL Programme in their various disciplines. Table 1 depicts the number of students trained in the DAL Programme over the last ten years. The upward trend since 2012 is as a result of tapered programmes to meet individual faculty needs.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic and Management Sciences</td>
<td>116</td>
<td>731</td>
<td>895</td>
<td>750</td>
<td>2136</td>
<td>1719</td>
<td>1777</td>
<td>1414</td>
<td>1791</td>
<td>2031</td>
<td>1983</td>
</tr>
<tr>
<td>Arts</td>
<td>187</td>
<td>374</td>
<td>121</td>
<td>497</td>
<td>587</td>
<td>355</td>
<td>398</td>
<td>400</td>
<td>433</td>
<td>386</td>
<td></td>
</tr>
<tr>
<td>Community and Health Sciences</td>
<td>781</td>
<td>413</td>
<td>303</td>
<td>375</td>
<td>530</td>
<td>475</td>
<td>516</td>
<td>452</td>
<td>406</td>
<td>403</td>
<td>384</td>
</tr>
<tr>
<td>Dentistry</td>
<td>31</td>
<td>33</td>
<td>26</td>
<td>28</td>
<td>27</td>
<td>126</td>
<td>135</td>
<td>106</td>
<td>152</td>
<td>121</td>
<td>156</td>
</tr>
<tr>
<td>Natural Sciences</td>
<td>97</td>
<td>116</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>125</td>
<td>109</td>
<td></td>
</tr>
<tr>
<td>Law</td>
<td>615</td>
<td>473</td>
<td>423</td>
<td>503</td>
<td>488</td>
<td>731</td>
<td>593</td>
<td>0</td>
<td>613</td>
<td>624</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>620</td>
<td>815</td>
<td>386</td>
<td>304</td>
<td>401</td>
</tr>
<tr>
<td>TOTAL TRAINED</td>
<td>1827</td>
<td>2140</td>
<td>1768</td>
<td>2153</td>
<td>3768</td>
<td>4026</td>
<td>4234</td>
<td>2758</td>
<td>3106</td>
<td>4125</td>
<td>3991</td>
</tr>
</tbody>
</table>

Table 1: Number of students trained in the DAL Programme (2005-2015).

The DAL team works closely with all faculties to ensure that students have a good first experience with eLearning at UWC. This consultative approach assists in encouraging further eLearning possibilities for students and lecturers, once students are familiar with a range of basic eTools and resources. The DAL course content is an attempt to level the playing fields for underprepared students who have had little or no access to digital media for academic purposes. The customisation offered in the DAL Programme also assists in the development of graduate attributes within specific disciplines.
Currently UWC has students enrolled who have not used any form of digital media in teaching-and-learning environments and whom possess little to no computer skills. Thus, while these students may fall into the Digital Native category, this term is problematic in a UWC context.

1.2 Digital Natives

The term Digital Natives originated with Marc Prensky, who argued that the new generation of students entering universities were profoundly different to previous groups (Kennedy, Judd, Churchward, Gray, & Krause, 2008). The term is associated with students who were born after the year 1980 (Margaryan, Littlejohn, & Vojt, 2011) and were exposed to technology, computers and the internet from a young age (Bennett, Maton, & Kervin, 2008). Prensky believed that the brains of Digital Natives were physically different as a result of the home environment (Kennedy et al., 2008). Prensky (2001), quotes Dr. Bruce D. Berry as saying, “Different kinds of experiences lead to different brain structures” but notes that whether or not Digital Natives have physically different brains, their “thinking patterns have changed” (p.2).

Access to Information and Communication Technologies (ICTs) does not necessarily equate to understanding or the ability to apply ICT skills to academics. As Czerniewicz and Brown (2005) note, access does not directly relate to increased “value for education” (p.1). Especially within an African context, one cannot adopt a Western theory without adapting it. As universities adapt to cater to a new digital generation, support is crucial as many students and staff are not comfortable with ICTs. Too often there is an assumption that introducing ICTs results in improvements (Shaikh, 2009) without considering other factors.

The following section presents a brief review of the literature.

2. Literature Review

2.1 Growth of ICTs in Education

Worldwide, Higher Education (HE) is undergoing a major shift due to the increase in ICTs (Czerniewicz & Brown, 2009) which cannot be overlooked as they have become a “driving force behind the quality of education” (Shaikh, 2009, p.64). Higher Education Institutions (HEIs) in Africa are continuously striving to improve and transform the use of ICTs in various areas including teaching-and-learning, communication and research (Adam, 2003). Despite scarce resources and other challenges, universities spend more on ICTs than they previously did (Czerniewicz & Brown, 2005).

In South African HE, the adoption of ICTs and effective eLearning practices have become crucial policy goals in order to increase the participation and throughput of students from previously marginalised groups, and equip them with skills for social transformation (Jaffer, Ng‘ambi, & Czerniewicz, 2007). These policy goals, as highlighted in the White Paper (2013), emphasize government’s call to implement ICTs into HE programs to “[i]mprov[e] student access” (p.49). “[S]uccess and throughput rates [are] a very serious challenge for the university sector and must
become a priority focus for national policy and for the institutions themselves.” (White Paper, 2013, p.31)

2.2 University of the Western Cape

With an awareness of UWC’s mission and the information economy’s demands, an eLearning support unit (now called CIECT) was founded in 2005 to promote the adoption of innovative technologies and support the UWC community by developing skills and ePedagogy to enhance teaching-and-learning practices. This is in alignment with UWC’s IOP which stipulates under Goal 2, Strategy 1 that the university will “[i]mprove and professionalise teaching and learning across the institution” and aim for “[g]reater infusion of technology into the curriculum” (p.13).

The following section discusses the Methodology.

3. Methodology

This study was reviewed by the UWC Faculty Board Research Ethics Committees and then by the UWC Senate Research Committee where it was approved (Registration number 15/4/3). The researchers identified no conflict of interest.

A mixed-methods approach was adopted to eliminate the bias of one data source (Denzin in Johnson, Onwueguzie, & Turner, 2007) and through sequential triangulation, used existing data to design the second phase of data collection (Johnson et al., 2007). Both quantitative and qualitative data were retrieved from CIECT’s intranet, Integrated Data Management and Processing System (IDMPS); an internet-based ICTs Access Survey; student assessment results after engagement in the DAL Programme; and contributions by the DAL facilitators.

The online survey was designed once analysis of existing data from the DAL database was underway, in order to strengthen the study. Feedback from experts in the field also proved vital in designing the study as they held a wealth of knowledge regarding the programme which, assisted in substantiating and guiding the research direction.

The following sections provide an overview of the target population, data collection techniques, and potential limitations of the study.

3.1 Sample

The sample consisted of the 2734 students participating in the DAL Programme at UWC during the first semester of 2015. Tables 2 and 3 indicate student demographic data.

<table>
<thead>
<tr>
<th>Age Groups</th>
<th># of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-30</td>
<td>2287</td>
</tr>
<tr>
<td>30+</td>
<td>74</td>
</tr>
<tr>
<td>Did not indicate</td>
<td>372</td>
</tr>
<tr>
<td>Incorrect entry</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 2: Age breakdown of 2734 students in the 2015 DAL Programme (from CIECT’s IDMPS).

<table>
<thead>
<tr>
<th>Gender</th>
<th># of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>1193</td>
</tr>
<tr>
<td>Females</td>
<td>1510</td>
</tr>
<tr>
<td>Did not indicate</td>
<td>31</td>
</tr>
</tbody>
</table>

Table 3: Gender breakdown of 2734 students in the 2015 DAL Programme (from CIECT’s IDMPS).

It should be noted that the data retrieved from the IDMPS represents the larger group of respondents. Following, the discussion reflects specifically on the data drawn from the ICTs Access Survey.

Within the larger sample group, a smaller sample group consisting of 1414 students completed the ICTs Access Survey (using Google Forms). The majority of these students were first years under the age of 21 (n=1228, 86.8%). Most were full-time students (n=1379, 97.5%), and 2.5% were part-time students. Survey respondents represented six out of seven faculties. Most respondents were from the Economic and Management Sciences Faculty (n=741, 52.4%), followed by Education (n=295, 20.9%), Arts (n=227, 16.1%), Community and Health Sciences (n=114, 8.1%), Dentistry (n=34, 2.4%) and Law (n=3, 0.2%).

The following section presents information gathered via data collection techniques.

3.2 Data Collection

The data collection techniques consisted of three parts namely, Observations by Subject Matter Experts (SMEs), extracting the relevant data needed from the IDMPS and, conducting the ICTs Access Survey.

The SMEs set-up and manage the IDMPS from which most of the quantitative data were retrieved. Through analysis of the data, researchers identified a gap related to student ICTs access which led to the design and distribution of the ICTs Access Survey.

Each of these data collection techniques is discussed in more depth below.

3.2.1 Observations by Subject Matter Experts

The SMEs referred to in this context are the DAL facilitators who train and support students within the DAL Programme. Their other roles include meeting with faculty representatives to structure tailored programmes according to student needs, monitoring face-to-face training interventions, providing consultations, managing student assessments, administrative activities and, managing the IDMPS. Their intensive involvement in all aspects of the DAL Programme means their observations and input have high validity and authenticity aligned to Neuman’s (2003) statement of...
“giving a fair, honest, and balanced account of social life from the viewpoint of someone who lives it every day” (p. 185).

3.2.2 Integrated Data Management and Processing System

Data related to first years engaged in the DAL Programme is stored in CIECT’s intranet, the IDMPS. It is a platform which records information regarding the initial understanding and ability of students according to their reflections in a questionnaire completed upon entering the programme. Additionally, it monitors their progress and final results upon completion of the course. Access to the IDMPS is limited to approved institutional desktops that have the client installed. These clients connect to the password-protected server through a secure network and access is restricted by multiple password layers.

3.2.3 ICTs Access Survey

The ICTs Access Survey was designed to gain additional data needed for the study, after reflecting on data retrieved from the IDMPS. The online survey was conducted using a single-page Google Form which was embedded into the institutional Learning Management System (LMS), namely iKamva/Sakai. Students accessed the survey via the DAL course page and it was accompanied by a digital consent form which had to be acknowledged before survey results would be included in the study. All respondents remained anonymous and all questions were closed-ended.

This surveying method was selected for four reasons. Firstly, researchers aimed to limit the impact participation would have on class time. Second, it was convenient and accessible as the classes are situated in a computer laboratory environment. Third, it was the most cost-effective technique for such a large target population (2858). Finally, self-administered questionnaires are seen as “very effective, and response rates may be high for a target population” (Neuman, 2003, p.289).

The survey underwent testing by the CIECT team prior to it going live, to ensure completion within a short time-frame. After the testing phases, the survey was live from 9-23 March 2015.

Students were motivated by the DAL facilitators to engage voluntarily in the survey, in order to create awareness regarding its content and purpose, which was to determine access to ICTs within their home and community environments.

Due to the predominantly qualitative nature of the study, a nonprobability, purposive sampling method was used, to conduct an in-depth investigation of the Digital Natives at UWC. This produced a sampling ratio of 49.5% (1414 out of 2858) which limits the sampling error due to the high participation rate.

It was important that the researchers reflected on the limitations of the data collection techniques.
3.3 Limitations

A possible limitation was the validity of student reflections regarding their own abilities related to ICT competencies. During the analysis of this entry questionnaire (placed on CIECT's intranet, IDMPS), inconsistencies arose as a limited number of responses were not aligned. An example being that 253 students indicated they could send and retrieve emails, but a higher number (278) indicated they could add an attachment to an email. One would assume that if you could add an attachment to an email, you would be familiar with simpler email commands such as send and retrieve. These inconsistencies could indicate that some students did not answer honestly or simply “clicked through” questions resulting in invalid responses. This is referred to as a “response bias” – where participants agree or respond similarly to a large number of questions as a result of “laziness or a psychological pre-disposition” (Neuman, 2003, p.197).

Another possible limitation related to the ICTs Access Survey, was participants who fell outside the target group. This is unlikely as the reason for data collection was explained to participants however, due to limited access control and anonymous responses; the link could have been forwarded to people outside the target group (Stanton & Rogelberg, 2001). To ensure that the majority of responses were from within the target population, researchers compared the time-stamps of survey submissions to the DAL class times and found that the majority of responses (n=1300, 91.42%) were submitted during class and in the ten minutes after class (n=54, 3.79%). This proves that it is likely most responses were submitted by the target population (DAL students) under supervision. The researchers also acknowledge the possibility of participants submitting multiple entries, either by accident or purposefully. Due to many students utilising the same computers on campus, IP address filtering was not an option to prevent multiple entries.

Another possible limitation is that of researcher bias, as the DAL Coordinator is a researcher in the study and played a crucial role in drafting questions for the online survey as well as in data analysis. However, through triangulation and multiple researchers working collaboratively, the probability of researcher bias is low.

In the following section the findings are discussed.

4. Research Findings and Discussion

The four sections below will reflect on: (i) Observations by the DAL facilitators regarding the phenomenon of the Digital Natives and its relevance at UWC, (ii) findings from the IDMPS regarding the initial abilities of first years entering the DAL Programme, (iii) findings from the ICTs Access Survey, and (iv) reflections on the assessment and moderation process in the DAL Programme.
4.1 Observations by Subject Matter Experts

The DAL facilitators serve the UWC community through their numerous and intensive roles which they balance within the natural environment and the impact they have on students, which make their observations valuable to the study.

In asking the facilitators whether they agreed with the concept of the Digital Native, within a UWC context, the general response was negative:

“A person born post-1980 might be brought up during the "digital age" but this does not mean they are familiar with computers or the internet.”

Another elaborated:

“[Assumption[s] that all students today are technologically savvy is not true at UWC or most of Africa for that matter, where there are very few who are tech savvy. [...] Yes there are those who at times feel bored because they already know but, those are the lucky ones who grew up in well off families and went to 'so called' better schools. The fact that students are so familiar with social networks [...] does not mean they can write an academic paper or fulfill the academic requirements.”

The facilitators further commented on the impact of the DAL programme:

“The DAL Programme has a positive impact on students’ academic careers, as they are able to complete assignments and other tasks that require the use of the packages or tools we have taught them. A great deal of students still have minimal exposure to computers when finishing high school, therefore DAL would be an integral part of making their academic career a success.”

And:

“[Students] complain about the short duration of the programme and wish it were the entire year. Some even feel that it should be a module on its own and not form part of another module e.g. 10-15%. That is an indication that the programme is making a huge difference in their academic life and beyond.”

These observations prove that the DAL Programme is still needed and we examine this more closely in the following section.

4.2 Integrated Data Management and Processing System

Tables 4-7 provide a break-down of student ICT competencies, based on responses to the entry questionnaire: (i) Initial abilities related to basic digital literacy skills; (ii) Initial abilities related to web-browsing and Email usage; and (iii) Initial abilities related to Microsoft Word.
Table 4: Students’ initial indication of their abilities related to Basic Digital Literacy Skills.

The results indicate that many students did not possess basic digital literacy skills, including, (i) navigating the Windows Operating System; (ii) identifying basic computer components; (iii) understanding basic software; (iv) desktop management; (v) identification of virus alerts; and (vi) basic ICT etiquette in a computer lab and online.

The DAL Programme remains crucial as, lecturers expect students to prepare electronic academic assignments, reports and presentations. The DAL facilitators share an awareness of this expectation and the need to address it:

“[E]xpecting a student [...] who does not have any experience with computers, to be highly efficient in his tasks as a student, that expectation is almost ludicrous. [...] [S]omebody has to facilitate that transition [...] from being a novice computer user to being a good computer user leading on to becoming a great computer user.”

And:

“[T]hey won’t complete their studies efficiently without having basic computer literacy. [...] There are those that did CAT at high school and they are familiar, but there are those that have never even worked on a computer. We largely cater to those people because it will be impossible for them to complete their degree or their studies if they cannot type their assignments [...] [or log] onto Ikamva to do their tests.”

Many local schools offer the subject Computer Applications Technology (CAT) from grade 10-12, which includes theory and practical aspects (De La Salle Holy Cross College High School website, 2010). However, many students who enter university and have not taken CAT, have failed it or have not had the opportunity to engage with ICTs at all. This gap must be addressed by the DAL Programme.

Table 5 and 6 deliberate the need for the DAL Programme in relation to expectations regarding communication, completing academic papers and submissions of assignments.
Table 5: Students’ initial indication of their abilities related to the Internet/Email.

<table>
<thead>
<tr>
<th></th>
<th>Unable to:</th>
<th>Able to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigate the Internet</td>
<td>21</td>
<td>286</td>
</tr>
<tr>
<td>Conduct Academic Searches</td>
<td>22</td>
<td>285</td>
</tr>
<tr>
<td>Access Email</td>
<td>17</td>
<td>290</td>
</tr>
<tr>
<td>Send and Retrieve Email</td>
<td>54</td>
<td>253</td>
</tr>
<tr>
<td>Add an Attachment</td>
<td>29</td>
<td>278</td>
</tr>
<tr>
<td>Email Etiquette</td>
<td>52</td>
<td>255</td>
</tr>
</tbody>
</table>

Even though it is apparent that most students are able to complete the above tasks, related to web-browsing and email, it is important to note that there remains a need for the DAL Programme to assist those students who are being left behind academically. Digital Strangers who enter university without ICT access and knowledge, are experiencing a widening digital gap “as they have to prioritize ICT use and make hard choices which generally do not include making use of social software and exploiting Web 2.0 opportunities” (Brown & Czerniewicz, 2010, p.8).

Throughout a student’s university career, they are expected to navigate the internet and conduct academic searches via search engines. Lecturers also expect students to make use of the library’s electronic database for research purposes and submit academic assignments, reports and presentations via iKamva, email and Google Applications.

The results in Table 6 emphasize the high number of students who, upon entering the DAL Programme report struggling with basic Word processing tasks required to succeed at university on a daily basis namely, (i) Creating, editing, formatting, saving and management of a Word document and, (ii) Storage of content in various locations such as, the desktop, a flash-drive, or cloud-based systems.

Table 6: Students’ initial indication of their abilities related to Microsoft Word.
Looking at these results we see that a large number of students are unable to complete basic ICT tasks and therefore rely on the DAL Programme to succeed academically. Implementation of this programme by 17 departments at UWC, who identified a need for student training in ICT basics, in order to cope with their tertiary studies, is eye-opening considering that according to Prensky (2005), the Digital Native generation should be fluent in the digital language.

In the following section we examine the results from the ICTs Access Survey.

4.3 ICTs Access Survey

The ICTs Access Survey was designed and distributed after analysing the existing data and identifying a gap related to whether or not first year students had ICTs access off campus. The survey expanded the existing data and provided vital information needed for this study. Each section of the ICTs Access Survey will be discussed in relation to student responses.

The survey entailed four sections namely, (i) Background Information which gathered basic data on participants, while protecting anonymity; (ii) Cellphones which assessed student access and usage; (iii) Computer/Laptop/Tablet which measured participant access and usage; and (iv) Internet Access (usage patterns), which assessed student internet access, how frequently they used the internet and for which purposes.

The Background Information section of the survey is not discussed below as it has been covered in the Sample segment of this paper.

4.3.1 Cellphones

The first question posed asked: Do you own a personal cellphone? The majority responded Yes (n=1390, 98.3%) while a small group responded No (n=24, 1.7%). Participants who answered Yes were then asked: What do you primarily use your cellphone for? This question included an eleven-option checkbox list and participants were allowed to select multiple options. Table 7 reveals that Calls (n=1178, 83.3%) emerged as the top use, Chat (n=1157, 81.8%) second and, Social Networks (n=1076, 76.1%) as the third major use. Apart from the Other (n=27, 1.9%) category, which was the least selected option, the lowest ranked uses were Academic Purposes (n=896, 63.4%), Games (n=536, 37.9%) and Career Info (n=462, 32.7%).

<table>
<thead>
<tr>
<th>Cellphone Usage Results</th>
<th>Number:</th>
<th>Percentage:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calls</td>
<td>1178</td>
<td>83.3%</td>
</tr>
<tr>
<td>Chat (e.g. Whatsapp / WeChat / Viber etc.)</td>
<td>1157</td>
<td>81.8%</td>
</tr>
<tr>
<td>Music</td>
<td>1076</td>
<td>76.1%</td>
</tr>
<tr>
<td>Internet Searches (Recreational)</td>
<td>1054</td>
<td>74.5%</td>
</tr>
<tr>
<td>Email</td>
<td>1052</td>
<td>74.4%</td>
</tr>
<tr>
<td>Texts / SMS / MMS</td>
<td>1036</td>
<td>73.3%</td>
</tr>
<tr>
<td>Taking Photos / Video</td>
<td>993</td>
<td>70.2%</td>
</tr>
<tr>
<td>Academic Purposes</td>
<td>896</td>
<td>63.4%</td>
</tr>
<tr>
<td>Games</td>
<td>536</td>
<td>37.9%</td>
</tr>
<tr>
<td>Career Info</td>
<td>462</td>
<td>32.7%</td>
</tr>
<tr>
<td>Other</td>
<td>27</td>
<td>1.9%</td>
</tr>
</tbody>
</table>
Table 7: ICTs Access Survey results related to Cellphone Usage.

The following question asked: *If you own a cellphone, can you access the internet on it?* Most responded *Yes* \( (n=1335, 94.4\%) \) and a small number responded *No* \( (n=44, 3.1\%) \) indicating that most respondents had internet access on their phones. This was expected, considering that accessing the internet from your phone, is the cheapest internet option (Grandtruck in Brown & Czerniewicz, 2010) and that South Africa is 6th internationally for internet access via mobile devices (Brown & Czerniewicz, 2010). The final question in the section related to how the internet was accessed and three options were provided namely, *Using free Wi-Fi* \( (n=870, 61.5\%) \), *Using paid Wi-Fi* \( (n=305, 21.6\%) \) and *Using Airtime / Mobile Data* \( (n=1196, 84.6\%) \). Most students used airtime or mobile data off campus which probably is a result of no other access or, bandwidth limitations resulting in slower speeds or unreliable connections (Arabasz, Pirani, & Fawcett, 2003).

Most respondents were therefore cellphone users and accessed the internet on them thus, having some familiarity with aspects of digital technology. Although the primary uses were for non-academic purposes, approximately two-thirds of the respondents indicated some cellphone use for academic purposes. Therefore, potential exists for cellphones to be a useful tool for academic purposes especially once more mobile compatible platforms are implemented (Brown, 2003).

The following data shed light on respondents’ use of computers / laptops / tablets.

### 4.3.2 Computer / Laptop / Tablet

In this section the aim was to establish how many students had access to computers, laptops and/or tablets. The first question asked whether or not the student had access to any of these at home or, at their campus residence. The options were, *Yes* \( (n=1153, 81.5\%) \) or, *No* \( (n=261, 18.5\%) \). Students then selected all the devices they had access to at home. The most selected responses being *Laptop* \( (n=965, 68.2\%) \), followed by *Computer* \( (n=453, 32\%) \) and lastly, *Tablet* \( (n=414, 29.3\%) \). Additionally, participants were asked whether they had internet access on their device by selecting *Yes* \( (n=979, 69.2\%) \) or *No* \( (n=250, 17.7\%) \). The primary use of these devices was then explored and participants were asked to select multiple options from a list. The top selection which varies drastically from the cellphone usage responses, was *Academic Purposes* \( (n=1024, 72.4\%) \), followed by *Email* \( (n=915, 64.7\%) \). The lowest ranked uses were *Games* \( (n=342, 24.2\%) \) and *Skype/Video Chat* \( (n=239, 16.9\%) \).

Through examining the data, researchers identified the need to examine access beyond the immediate home environment too. The questionnaire therefore asked students to indicate whether they had access outside the home by selecting *Yes* \( (n=1032, 73\%) \) or *No* \( (n=382, 27\%) \). This was followed by a question regarding where they had access and a list with multiple options was provided. The responses: *On Campus* \( (n=889, 62.9\%) \), *Family/Relative* \( (n=379, 26.8\%) \), *Friend/Partner* \( (n=311, 22\%) \), *At Work* \( (n=55, 3.9\%) \) and lastly, *Other* \( (n=34, 2.4\%) \). Not surprisingly, the question related to the primary use of these computers produced similar results and the same order of priority, to the use of a home computer, laptop or tablet. *Academic Purposes* \( (n=946, 66.9\%) \), followed by *Email* \( (n=860, 60.8\%) \) and, the least selected being *Games* \( (n=211, 14.9\%) \) and *Skype/Video Chat* \( (n=120, 8.5\%) \).
## Computer / Laptop / Tablet Usage Results

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Purposes</td>
<td>1024</td>
<td>72.4%</td>
</tr>
<tr>
<td>Email</td>
<td>915</td>
<td>64.7%</td>
</tr>
<tr>
<td>Internet Searches (Recreational)</td>
<td>880</td>
<td>62.2%</td>
</tr>
<tr>
<td>Microsoft Office</td>
<td>875</td>
<td>61.9%</td>
</tr>
<tr>
<td>Social Networks</td>
<td>567</td>
<td>40.1%</td>
</tr>
<tr>
<td>Games</td>
<td>342</td>
<td>24.2%</td>
</tr>
<tr>
<td>Skype / Video Chat</td>
<td>239</td>
<td>16.9%</td>
</tr>
<tr>
<td>Other</td>
<td>62</td>
<td>4.4%</td>
</tr>
</tbody>
</table>

Table 8: ICTs Access Survey results related to Computer / Laptop / Tablet Usage.

### 4.3.3 Internet Access (Usage Patterns)

The last section in the survey related to Internet Access. Although the other sections had questions related to this topic, this section focused on how much time participants spent online and how they accessed the internet.

The first question in the survey was: **On average, how much time do you spend online/accessing the internet per day?** Responses included, 30 minutes - 2 hours (n=647, 45.8%), 2-5 hours (n=390, 27.6%), 0-30 minutes (n=206, 14.6%), 5-8 hours (n=120, 8.5%) and 8 hours+ (n=51, 3.6%). Researchers therefore deduced that most students do not spend excessive amounts of time on the internet and it becomes clear why, when delving deeper.

The second question posed was: **How do you most frequently access the internet?** Responses included, Hand-held Device (n=873, 61.7%), Computer/Laptop (n=529, 37.4%) and I don’t ever access the internet (n=12, 0.8%). When we consider that hand-held devices are the most popular form of internet access amongst students, it makes sense that time spent online would be limited as, “the cost of mobile and wireless technologies to the user […] will probably still restrict African learners to the use of mobile phones for a few years” (Brown, 2003, p.11). It is not surprising that this was the most prevalent form of access as, South Africa has “the highest cellphone uptake in Africa” (Brown & Czerniewicz, 2010, p.10).

While these results indicate that students have varied levels of access to electronic devices and the internet, gaps still exist for improving use (especially on mobile devices) and academic performance. The following section looks at the observations by DAL Facilitators in relation to pass and failure rates.

### 4.4 Moderation Observations by DAL Facilitators

#### 4.4.1 Assessment and Moderation Process

The assessments within the DAL Programme consist of Multiple Choice Questions (MCQs) and Practical Tests. All assessments are aligned with the module descriptor and set in accordance with course requirements. Once questions are drafted, they undergo multiple checks by team members, before approval for use in the official assessment process.
Approved tests are uploaded onto iKamva or the network drive and tests are completed in the computer laboratory on campus. MCQs are marked automatically through the system and tests on the network drive are marked manually by the DAL Team. Marks are captured onto an electronic marking grid which minimises errors and, these pre-moderation marks are accessible by faculty and students.

The following section analyses the student performance results.

4.4.2 Assessment Results

The numbers reflected in this section depict 2014’s assessment results after students had completed the programme. These grades are used as during the data collection phase, the 2015 results were not available.

The results were extracted from the IDMPS and captured on the institutional Marks Administration System of the university. Other data included the feedback received from the DAL facilitators who have worked in the natural environment and have witnessed the evolution of the programme.

Table 9 depicts the pass and failure rates of students. Despite the majority of our sample falling into the Digital Natives category, we see a high failure rate at the conclusion of the DAL Programme. As Brown and Czerniewicz (2010) note, “[i]nequality of access is a reality for South African students from low socio-economic groupings” (p.8) as well as those who do not have English as a home language. The digital divide overlooks what causes inequalities (Wolf in Moodley, 2005) as, it puts “too much emphasis [on][…] technology and has thus drawn attention away from the other divides” and factors which slow development (Moodley, 2005, p.7).

<table>
<thead>
<tr>
<th>Faculty:</th>
<th>Passed</th>
<th>Failed</th>
<th>Exam not taken:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arts</td>
<td>132</td>
<td>70</td>
<td>9</td>
</tr>
<tr>
<td>Community and Health Sciences</td>
<td>141</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>Education</td>
<td>213</td>
<td>87</td>
<td>88</td>
</tr>
<tr>
<td>Economic and Management Sciences</td>
<td>545</td>
<td>585</td>
<td>73</td>
</tr>
<tr>
<td>Law</td>
<td>478</td>
<td>31</td>
<td>83</td>
</tr>
<tr>
<td>Dentistry</td>
<td>105</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1614</strong></td>
<td><strong>800</strong></td>
<td><strong>264</strong></td>
</tr>
</tbody>
</table>

Table 9: Pass and Failure Rates of the DAL Programme for the 1st Semester of 2014.

Feedback from the DAL facilitators highlights this divide at UWC:

“*The majority of them, what contributes to when they pass is that they already have prior personal computer skills. The rest, they know how to do things on their phone or tablet but have not been exposed to a PC. Of course there are also those who come from deep rural areas, who have never even seen a PC. [...] How do you structure your session to accommodate everyone?*”
Another noted:

“Some students can communicate in English but others find it challenging to even have a conversation and it is therefore difficult for us as facilitators to establish what it is they [...] understand. [...] The rest of the class is kept behind as we are trying to explain or assist these students. Sometimes they don’t say anything or ask for help at all and this could also lead to a student failing.”

It is thus clear that within an institutional context there is “insufficient empirical evidence to support the [Digital Natives] concept” (Bullen et al. in Brown & Czerniewicz, 2010, p.3) as students who fall into this category may still be struggling to grasp basic concepts due to a range of factors. The role the DAL Programme plays is crucial despite various limitations preventing a 100% pass-rate upon completion of the programme.

In alignment with the IOP the DAL Programme makes a positive contribution to skills students need, not only at university but also once they transition into the working environment (Goal 2, Strategy 2). The programme is also committed to the “[g]reater infusion of technology into the curriculum” (Goal 2, Strategy 1, p.13).

5. Conclusion

The findings prove that although many students entering their first year at UWC may have had previous exposure to technology, there remains a need to educate students on the basic digital literacy skills needed at university level through specific support programmes such as the one offered by the DAL. The data suggests that Marc Prensky’s theory which assumes an entire generation is differently wired due to technological exposure is flawed. It is therefore impossible to accept a blanket theory which our data collection and analysis, proves untrue. Possible avenues for future research include further investigation into addressing the failure rate of students who fall into the Digital Native category.

6. Acknowledgements

The researchers would like to acknowledge that without the contributions made by the DAL Facilitators, this research study would not have been possible. We therefore extend our thanks to Kemal Adams, Joniff Cleophas, Tougida Fortune, Sonwabo Jongile and Fundile Nkunge for providing us with both the necessary data and personal insights needed to complete this paper.
7. References


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Individual Differences, Multi-Tasking and Learning in Virtual Environments

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Abstract
Virtual environments are inherently social spaces where user productivity and collaborative learning can take place. However, the majority of existing studies to date investigate common behaviours such as multi-tasking within traditional face-to-face learning environments. This study investigated the importance of structuring learning environments to maximize learning and minimize virtual distractions. Using an OpenSim virtual environment, the researchers conducted an experimental study during the Fall 2013 and Winter 2014 terms with 91 undergraduate students at the University of Alberta. The study investigated the influence of participants’ prior computer experience and extroversion-introversion on the impact of passive and social distractor tasks during learning and recall of factual information in virtual environments. The results indicated that prior video game use is a significant predictor of lower overall test time and higher overall test score, but the software recognition test, social networking use and virtual world use did not have a significant impact on learning performance. While extroverted individuals tended to complete questions faster under the interactive-type distractor condition, they achieved higher accuracy scores under the passive or no distractor-type conditions. Introverted individuals tended to complete questions faster and more accurately under the no distractor-type condition.

Keywords: multitasking, distractor, computer experience, extroversion, introversion, cognitive style, field independence, field dependence, virtual environment, learning, education, technology
Introduction

Research Problem

With the ever-evolving ubiquitous technologies accessible by many individuals, the desire for immediate communication, multi-sensory stimulation and instant gratification continuously bombard students with a multitude of “wired” interruptions that are filtered and addressed predominantly through multi-tasking (e.g. Carrier, Cheever, Rosen, Benitez, & Chang, 2009, Gazzeley, 2014). As educational philosophies, systems and institutions attempt to keep up with the changing socio-cultural and technological landscape, many educators seek bottom-up approaches to bridge current educational practices and the communicative tools that engage students to learn. Motivating students to focus on the learning task at-hand is particularly challenging for educators because social communication tools are increasingly mobile and consequently encompass a greater capacity for users to simultaneously interact, network and perform other tasks. As more and more educational platforms move online, educators must be cognizant of their students’ tendency shift or divide their attention among multiple stimuli. Thus, it is particularly important for educators to structure learning activities or the classroom in a way that maximizes learning and minimizes virtual interruptions.

Previous Studies Addressing the Problem

As students increasingly employ technology-based multi-tasking as an information management strategy (Chun, Golomb, & Turk-Browne, 2011), a growing body of concerned educators and researchers is examining the effects of frequent multimedia task-shifting on student learning, academic performance and overall attentiveness (e.g., Eby, Vivoda, & St. Louis, 2006). Previous literature indicates that there is a mismatch between students’ perceived ability to multi-task with digital technologies and the reality that attending to multiple stimuli can significantly impair task performance (Fried, 2008; Grace-Martin & Gay, 2001; Hembrooke & Gay, 2003; Junco & Cotton, 2011; Kraushaar & Novak, 2010). Younger adults are especially prone to multi-tasking because they carry the misconception that multi-tasking with technologies is an easy or efficient approach to handle massive amounts of information (Junco & Cotton, 2011). To date, the majority of studies investigate the multi-tasking behaviours of post-secondary students using technologies and the resulting effects on their learning abilities within face-to-face environments.

Research Questions

This study will investigate two main research questions stemming from human multi-tasking behaviours including whether distractions have an effect on learning within a virtual environment. The first research question addresses computer experience, factual learning and cognitive load. Specifically, research question 1 was divided into two sub-questions: 1A) Can prior computer experience predict learning performance as measured by overall test time in a virtual environment? and 1B) Can prior computer experience predict learning performance as measured by overall test score in a virtual environment?
The second research question investigates the personality dimension of extroversion/introversion on learning performance in the presence of interactive distractors, which are social in nature for this study. Since the data analysis will divide participants into two groups based on the category of extroversion/introversion, research question 2 is divided into four sub-questions: 2A) Is there a difference for extroverts in time on task given the type of distraction (interactive, passive, none) that is present? 2B) Is there a difference for introverts in time on task given the type of distraction (interactive, passive, none) that is present? 2C) Is there a difference for extroverts in accuracy on task given the type of distraction (interactive, passive, none) that is present? and 2D) Is there a difference for extroverts in accuracy on task given the type of distraction (interactive, passive, none) that is present?

Literature Review

Individual Differences and Personality on Multi-tasking Ability

While most studies of multi-tasking ability agree that digital technologies tend to be distracting and impair learning performance (e.g. Fried, 2008, Junco & Cotton, 2011, Kraushaar & Novak, 2010), few studies have investigated how personality traits and individual factors may impact multi-tasking ability on learning. One recent study by Sanbonmatsu, Strayer, Medeiros-Ward & Watson (2013) found a correlation between participants with high impulsivity and sensation-seeking scores to frequent multi-tasking while driving, however, they caution that these heavy multi-taskers tend to have lower executive control and are thus unable to block out distractions and focus on a single task as compared to light multi-taskers.

Using functional magnetic resonance image (fMRI), Gazzaley (2014) found that multi-tasking correlates with different levels of brain activity in the prefrontal cortex— the main information-filtering centre for the brain— thereby providing some evidence that multi-tasking may affect cognitive load or performance during learning and information processing in the brain. Gazzaley (2014) also speculates that age may be a factor in multi-tasking ability as younger people tend to be faster in switching attention from one task to another, likely because of higher brain plasticity during youth and young adulthood. In addition, today’s youth are often digital natives who have grown up with technologies— thereby allowing repeated exposure and practice in multi-tasking with technologies, video games and media.

On the other hand, Stanford Professor Clifford Nass found in multiple studies that those who were heavy media multi-taskers performed poorly compared to light media multi-taskers. Specifically, heavy media multi-taskers were slower to switch from one task to another involving combinations of letters and numbers (Nass, 2010). Nass’ studies suggest that there is a tendency for people to be over-confident in one’s ability to multitask without negative effects on his or her performance. Similarly, Sanbonmatsu, Strayer, Medeiros-Ward & Watson’s (2013) study also found that perceived multi-tasking ability was highly inflated as compared to actual multi-tasking performance. However, there maintained a slight positive correlation among those who self-reported greater multi-tasking ability and actual performance (Sanbonmatsu, Strayer, Medeiros-Ward & Watson, 2013).
Despite these preliminary findings, there is still a wide variability among individual abilities to filter relevant information and multi-task by attending to one task while ignoring others—as such, some researchers suggest that there are common personality factors and differences that correlate with working memory capacity or executive control— which may allow some people to control or attend to various stimuli or tasks better than other individuals (Sanbonmatsu, Strayer, Medeiros-Ward & Watson, 2013).

**Virtual Worlds for Education**

The embodiment of technologies molds today’s society into a world that thrives on the interconnectedness of global media and participatory culture (Jenkins, 2009). In particular, technology-mediated communications has become prominent in altering the way humans develop and understand the world. For instance, emails provide a mode of communication filled with few or ambiguous emotional and non-verbal cues (Smith & Kollock, 2003). Many technologies were developed in attempts to fill the missing elements of face-to-face interactions or simulate the human presence. One such technology involves the immersive experiences offered by virtual worlds or environments. Virtual worlds are generally characterized as simulated three-dimensional (3D) environments that are both immersive and scalable (New Media Consortium and EDUCASE Learning Initiative, 2007). Within these environments, players are typically represented as an avatar that can communicate or interact with the space and other avatars in real-time (New Media Consortium and EDUCASE Learning Initiative, 2007). Virtual worlds should not be mistakenly equated to video games: while the latter occurs within virtual worlds, there is typically an end-goal for the player while virtual worlds are open-ended sandbox environments that do not necessarily have a specific objective. Some widely-popular examples of virtual worlds include Minecraft, MapleStory, IMVU and Second Life (Boechler, 2014).

While a wide variety of virtual environments are available, the most pertinent spaces for investigating educational applications can be found in virtual communities such as OpenSim1. Within the education literature there have been some early attempts to utilize virtual environments to teach specific subjects via Second Life 2 for health education (e.g. Angie & Zane, 2011), teacher education, higher-level education (e.g. Serpil, Nurcan, Gamze & Fatih, 2012) and teaching languages. These studies highlight the benefits of utilizing virtual environments in education, citing realistic simulation of events or interactions that can be transferred beyond the virtual environment. These virtual environments simulate real-life scenarios and often closely resemble the user’s appearance, communication style and interactions in the real world (e.g. Serpil et al., 2012). Serpil et al. (2012) also found remarkable success in maintaining student engagement with course content and project presentations in the Second Life environment, citing realism, flexibility in formats and self-directed pacing as significant benefits. Therefore, using OpenSim increases the external validity by simulating the real-world applications of virtual environments.

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1 OpenSimulator: an open source multi-user application server used to create virtual environments (www.opensimulator.org)

2 Second Life: an online, three-dimensional virtual environment developed by Linden Labs in 2003 in which users interact and navigate the environment as avatars (www.secondlife.com)
Methods

Data Collection

Study Design. This study examined the impact of different types of distractors affecting learning recall within a virtual world. In the first part of the study participants completed the "General Survey"—a combined questionnaire which includes the Computer Experience Questionnaire and the complete Eysenck Personality Questionnaire (Adult version). The General Survey functions as a self-reported personal assessment of (1) familiarity with technology, software, prior computer experience, virtual worlds and social networking between Elementary school age to the present time, as well as (2) personality traits in relation to extroversion-introversion tendencies.

Participants. For the sake of time and efficiency, a convenience sample of 91 participants was recruited from the undergraduate Education program at the University of Alberta from September 2013 to October 2014. Participants received a 5% credit towards an Education course, EDU210: Technology Tools for Teaching and Learning, for voluntary participation in the two-hour combined study or completion of an alternate assignment. The data of two participants were removed from the analysis because the participants did not complete the survey. Therefore, the final sample for analysis was 89 participants, of which 63 were female (71%) and 26 were male (29%). The data collected from participants were anonymized to protect their privacy.

Instruments. To control for the validity and reliability of the experiment, two pre-surveys serve as covariate measures to assist with statistical data analysis.

Computer Experience Questionnaire. The first pre-survey, the Computer Experience Questionnaire (Boechler, Leenaars, & Levner, 2008; see Appendix A), is an instrument that measures computer use throughout elementary, junior high, high school and at present. This survey includes Likert-scale questions intended to account for individual differences and experience with software recognition, video games, social media and virtual learning environments. Students self-report the range of hours spent on each category from not at all to more than 10 hours a week.

Eysenck Personality Questionnaire (Adult version). The Eysenck Personality Questionnaire (Adult version) contains 90 questions measuring three personality temperaments, with 16 questions intended to measure the degree of extroversion-introversion on a scale of 1-16, with scores of 0-8 being indicative of introverted tendencies and 9-16 as having more extroverted tendencies. In accordance with the Eysenck Personality Questionnaire analysis procedures, only 16 out of the 90 questions were considered in calculating the final score for extroversion-introversion—the remaining questions acted as fillers in order to reduce the likelihood that participants would predict the intent of the survey and answer according to demand characteristics. While the results could be interpreted as scores across a continuum, using dichotomous categorizations of extroversion/introversion allows for a greater interpretation of its impact on the test score and time. According to Eysenck Personality Questionnaire Manual (Eysenck & Eysenck, 1964), scores can be categorized such that a score of "1" would indicate low extroversion levels, which
could be interpreted as being "introverted", while a score of "14" would be considered high on the continuum of extroversion. A mid-score represents an intermediate level of extroversion. This interpretation approach allows for a more accurate reflection of personality traits within the sample. In order to allow for easy comparisons between extroverted and introverted participants, the categorical approach was used.

**Procedures.** For this quantitative study, an experimental design was used to “test [the] impact of treatment or intervention on [the] outcome” (Creswell, 2009, p. 145-146). To carry out the quantitative experiment, a within-subject design was utilized to control for variations among individual learning and assessment performance or speed. As such, the experiment included control variables and each participant encountered one of three randomly-ordered conditions – that is, distractor type – during the learning phase in virtual environment task. The first step involved recruiting 89 undergraduate students from the Educational Psychology research participant pool at the University of Alberta. These students received course credit for participating in the 1-hour session in a large classroom setting accommodating up to 20 students at a time. All participants were required to sign a consent form before the researcher gave specific instructions for each task.

The first task was to complete the General Survey which measures prior computer experience (Computer Experience Questionnaire) and degree of extroversion-introversion (Eysenck Personality Questionnaire). Following the pre-surveys, participants were instructed how to navigate in the virtual environment using the keyboard arrows and follow the coloured arrows along a pathway. They were also tasked with reading all the windows or any instructions on the billboards they encounter. Participants were also informed that the virtual environment task had two phases and they would need to complete both to the best of their ability. These virtual tasks were, in fact, divided into a learning phase and testing phase. During the learning phase, participants navigated as an avatar along a directed pathway and read a billboard passage about the history of the London Tube Stations-- a fairly uncommon topic to prevent prior knowledge from becoming a confounded variable.

**Experimental conditions.** While reading each of these passages, one of three conditions randomly appeared: an interactive chat distractor, a passive text distractor or no distractors. Each participant experienced all three conditions exactly four times in random order. The *interactive distractor* is defined as a secondary, unrelated task that appears in a new window during the main learning task and prompts the participant to selectively attend to, process and input a response accordingly. Four different interactive distractors were used in the study that questioned, in random order, the following: What is your major area of studies? What year of studies are you currently in? What is the last class you went to? Have you eaten lunch yet? (see Appendix G for example of an interactive distractor used in the virtual world).

The *passive distractor* is defined as a secondary, unrelated task that appears in a new window during the main learning task but only prompts the participant to selectively attend to the stimulus without inputting any response. Four different passive distractors were used in the study that displayed the following conversational statements in random order: I’m majoring in Biology; I’m currently in my third year of studies; I just finished History class; and I just had lunch in the cafeteria (see Appendix G for example of a passive distractor used in the virtual world). Both the
interactive and passive distractors were written in a conversational tone in order to make the distractors more authentic to external distractors found in real-life and virtual settings; this is in contrast to other distractor studies (e.g. Nass, 2010) that utilize math, image identification or vocabulary questions, for example, as a distractor.

The control condition in the study, *no distractor*, means that participants did not encounter a distractor while reading a billboard. This condition was also randomly selected during each session. Participants will be drawn from a convenience sample of undergraduate students enrolled in Education courses at the University of Alberta. For each participant, the distractor type was recorded alongside each randomly-matched billboard in order to properly assess the mean scores for factual learning recall as influenced by each distractor type.

**Learning task.** Note that participants were not primed to learn the information for testing specifically but to simply read the billboards in order to reduce the impact of test-wiseness and demand-characteristics (See Baddeley, 1997; Hulstijn, 1989). During the testing phase, participants completed a multiple-choice test displayed on the final billboard to assess factual learning recall of the information previously presented. The OpenSim virtual environment allowed for time-tracking throughout each phase, including the specific time taken to navigate or walk within the virtual environment, reading time for each billboard and completion time for the test questions. Participants’ learning performance on factual learning recall was assessed by analyzing the overall score out of 12 and total time taken to complete the multiple-choice test.

**Enhancing validity and reliability.** In an effort to enhance the internal validity of the experiment, the researcher purposefully excluded the use of a pre-test of the test topic about the history of the London Tube Stations in order to reduce potential threats caused by repeated testing. By doing so, the researcher can be more confident in the results since participants will not become more familiar with the outcome measure or potentially remember responses for the post-test.

**Results**

**Definition of Terms for Analysis**
To begin, the following terms must be clarified. The “overall test time” refers to the time in minutes taken to complete the 12-item multiple choice test during the virtual world testing phase (phase two) of the study. Here, participants demonstrated their factual recall ability of the billboard information presented during the learning phase (phase one). The “overall test score” refers to the number of correct responses in the 12-item multiple choice test, with 1 score awarded for each correct response up to a maximum of 12 and no score added for incorrect or missing responses. For research question 2, “time on task” refers to the time taken to complete four multiple choice test questions based on the three types of distractors (interactive, passive or none) presented while participants read billboards during the learning phase. Similarly, “accuracy on task” refers to the number of correct responses up to a maximum of 4 multiple choice test questions based on these three types of distractors.
Research question 1. The first question examines whether prior computer experience predicts learning performance as measured by (A) overall test time, and (B) overall test score, in a virtual environment. Since research question 1A seeks to understand if prior computer experience predicts learning performance as measured by overall test time in a virtual environment, a multiple regression analysis was used. The independent variables include the components used in the Computer Experience Questionnaire including the software recognition test, total video game use, total social networking use and total virtual world use; the dependent variable is the overall test time for recalling information from the billboards, which is a continuous variable. Based on the hierarchal multiple regression analysis results, Total Video Game Use significantly predicted MC_test_time, F(3, 85) = 5.419, p < .0005. The Adjusted R Square is 0.131 or 13.1%, which suggests a small effect size.

Research question 2. For the second research question, the sample group was further divided into a category of extroverts and introverts based on the scores obtained from the Eynseck Personality Questionnaire in order to determine if there were test time or test score differences for either group based on distractor types. As the sample was drawn from undergraduate education students on a voluntary basis without specific requirements, an uneven distribution of extroverts and introverts were already present (n= 64 and n=25, respectively). As such, this sample was an authentic reflection of the undergraduate education student population, which can be used to draw further implications for research in this specific context.

According to the results discovered in research questions 2A and 2B, introverted participants took slightly more time to answer questions in the presence of interactive distractors (M = 4.718, SD = 0.182) and no distractors (M = 3.109, SD = 0.176), but took relatively less time in the presence of passive distractors (M = 4.054, SD = 0.213) than the extroverted participants (Interactive: M = 3.600, SD = 0.117; None: M = 3.093, SD = 0.113 and Passive: M = 4.309, SD = 0.137, respectively). For extroverts (question 2C), accuracy on task for distractor type was highest for passive distractor (M = 3.22 ± SD = 0.888 score), moderate for the control condition with no distractors (M = 2.683± SD = 0.997 score) and lowest for the interactive distractors (M = 2.32± SD = 1.060 score). For question 2D, the ANOVA revealed that for introverts, accuracy on task for distractor type was highest for the control condition of no distractors (M = 3.72 ± SD = 0.737 score), moderate for passive distractors (M = 3.280± SD = 0.178 score) and lowest for the interactive distractors (M = 2.440± SD = 0.259 score).

Discussion of Results

For research question 1, it was found that only video game use was a significant predictor of overall test time and test score. That is, more prior experience with video games predicts lower overall test time and higher test scores. Interestingly, the time in which prior video game experience was acquired did not affect overall time or accuracy. A probable explanation for this result is that video games require players to attend to multiple stimuli and task-shift quickly. For example, the game interface may have multiple gauges for health points, magic points, score, inventory, etc. displayed while players are engaging in interactive events during gameplay. Therefore, the repeated practice and exposure within video games likely decreased cognitive load for similar onscreen activities such as playing in a virtual environment. Also, since video
games are often set in virtual environments, they may have already acquired skill sets that allow them to quickly skim material and recognize cues that aid information recall. As exposure and experience in video games is accumulated over time, the specific time period in which this experience occurred would be irrelevant. Software recognition and social networking use may not have had a significant effect because the skills required in these activities would be less relevant to the virtual environment tasks at-hand. For instance, the virtual world did not analyze the accuracy of social responses or require recognition of other types of software such as SPSS.

For research question 2, extroverts tended to take the most time to complete the test during the presence of passive distractors instead of interactive distractors. This result may reflect arousal theory in that extroverts may require more stimulation and have a higher threshold for social activity; thus the researcher speculates that there is an optimal level of arousal that benefits extroverted individuals when they learn in the presence of interactive distractors that are socially-oriented. In addition, extroverts may be more adept at managing social interactions while multi-tasking and may require less time formulating a response because of their predisposition to value social interactions over factual learning required for the test. Thus, the extroverts may have rushed through the test or were less concerned about the test performance. Also note that extroverts actually obtained the worst test scores for interactive distractors. This may indicate that while extroverts may be quick to complete the test, they did not process the primary task as effectively when information was presented in the presence of interactive distractors. Thus, while experience or comfort with social situations may predict faster response times, accuracy scores may decrease as the reduced time needed may require greater processing or mental exertion. Consequentially, less cognitive processing is allocated to the primary task.

On the other hand, introverts tended to take the most time to complete the test and had the lowest test scores during the presence of interactive distractors. In line with the arousal theory, introverts have a lower optimal level of arousal, which interactive distractors will likely overshoot. As a result, introverts perform relatively poorly in response to too much arousal. In addition, introverted participants may be more easily distracted by interactive messages or utilize more attentional resources to process interactive distractors because of less experience or greater discomfort in social situations. Furthermore, the extra time used for responding to the test questions may have been a reflection of more careful concentration or focus on the primary task.

Assumptions and Limitations

Some assumptions of this true experimental design include the internal validity of test scores and completion times as indicators of the quality of factual learning, as well as the fact that participants are moderately motivated to learn within the virtual environment to obtain course credit or to experience alternate delivery formats in education. The study did not account for test-wiseness or familiarity with the test topic. Furthermore, while the study examined three levels of distractors, distractions can come in many forms and contexts. For example, this study only investigated visual, social distractors. Future studies could examine distractors involving audio or kinaesthetic elements. These unexamined distractor types may reflect real-life situations an individual may encounter in cases such as receiving a video call, playing music while working on a task or being alerted to a message through the vibration of a
phone. Other avenues for future exploration could address the hypothesis that learners may exert less cognitive effort when switching between tasks while using the same device or one computer in comparison to switching between various devices. In this case, the proximity or immediacy of the distractions may have an effect on the participant’s performance when learning within the virtual environment. Another limitation of the study is that the results may not apply to other populations such as children, adults not in post-secondary education. Future research into different populations and fields may be required.

Conclusion

Based on the results of this study, video game experience may aid multi-tasking performance through familiarity of simultaneously attending to various stimuli on the computer screen. In addition, since video games take place in virtual environments, the transfer of skills and comfort with these platforms may translate to better performance on factual learning recall during distractions. However, more generalized experience with computers such as software recognition or familiarity with social media does not seem to have such an impact—perhaps because they train a different set of skills on a different platform.

Personality traits also seem to have some predictive value for the ability to effectively multi-task and recall factual information during a test. Specifically, extroversion may predict faster test times but lower accuracy scores compared to introverts due to the predisposition to value social or interactive tasks over factual applications. Overall, while preliminary research in virtual learning environments has demonstrated that some personal factors may affect the impact of multi-tasking on factual learning, there is still much to uncover about the effect of distractors on various learning tasks and diverse populations. These insights may enhance one’s understanding of learning in the technological, multi-tasking world.
References


**A Method of Estimating Cooperative Activities in Collaborative Learning based on Participants' Spatial Relationships**

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Hiroaki Kimura, KDDI R&D Laboratories, Inc., Japan

Abstract

Collaborative learning has become more and more important in education area. In most collaborative works, students are separated into groups, where the possible scope of teachers might be strongly limited. Therefore, automatic feedback based on sensing the state of students during collaborative work is helpful for effective educational guidance. In this work, we focus on the spatial relationships of each participant pair and tried to examine the feasibility of estimating learners' cooperative activities. To achieve this purpose, KINECT is used to record space coordinates of learners during collaborative works. As the objective evaluation, average distances between students were calculated in every 10 seconds based on the recorded data. On the other hand, the subjective evaluation was performed by 6 researchers with monitoring the collaborative work video and giving a 5-grade mark for each pair of students in every 10 seconds.

In order to verify the effectiveness of the spatial measurement, we calculated the correlation coefficient between objective and subjective evaluation within a one-minute time window, which is shifted by 10 seconds through the collaborative work (ca. 5 minutes). The result shows that the 1-minute time spans with correlation coefficients of 0.5-0.85 occupied around 47% (in average) of the whole collaborative work, during which students are cooperatively learning. This suggests that the spatial relationship is able to estimate the existence of cooperative activities between students, and is able to be used for online student state detection. In our future work, students' posture, gesture and verbal data should be also involved.

Keywords: Collaborative learning, correlation coefficient.
**Introduction**

"The principle goal of education is to create men who are capable of doing new things, not simply of repeating what other generations have done - men who are creative, inventive and discovers." Developing meta cognitive, creative, and communicative skills is still an educational goal today, and one that should view learning as a process of acquiring and building knowledge with a strong social and experiential component. Learning to work with others and collaborate has become an extremely important skill.

In most collaborative learning cases, students are separated into groups, where the possible scope of teachers might be strongly limited. Therefore, automatic feedback based on sensing the state of students during collaborative learning helps make educational guidance effective and efficient.

**Approach**

In this ongoing study, we focus on the spatial relationships of each participant pair and tried to examine the feasibility of estimating their cooperative activities.

To achieve our purpose, KINECT is used to record space coordinates of learners during collaborative learning. As the objective evaluation, average distances between two students were calculated in every 10 seconds based on the data recorded by KINECT. On the other hand, the subjective evaluation was performed by 6 researchers, monitoring the collaborative learning video and giving a 5-grade mark for each pair of students in every 10 seconds.

**Experiments and results**

In order to verify the effectiveness of the spatial measurement, we calculated the correlation coefficient between objective and subjective evaluation within a one-minute time window, which is shifted by 10 seconds through the collaborative learning.

47% (in average) of the whole collaborative learning process were detected to correlate with subjective evaluation, in which correlation coefficients were 0.5-0.85. Due to less movement of students or noise data, the proposed scheme need to be improved to extract exact state of students.

![Figure 1: Experiment setting of collaborative learning.](image-url)
Figure 2: Objective evaluation based on KINECT log data.

Table 1: Subjective evaluation grades.

<table>
<thead>
<tr>
<th>Grades</th>
<th>Collaborative relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Strong</td>
</tr>
<tr>
<td>4</td>
<td>Weak</td>
</tr>
<tr>
<td>3</td>
<td>Unknown</td>
</tr>
<tr>
<td>2</td>
<td>None</td>
</tr>
<tr>
<td>1</td>
<td>Self-contained</td>
</tr>
</tbody>
</table>

Table 2: Results of subjective and objective evaluation

<table>
<thead>
<tr>
<th>Grades of B-C.</th>
<th>Average distance (metre).</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.93</td>
</tr>
<tr>
<td>4</td>
<td>0.88</td>
</tr>
<tr>
<td>4</td>
<td>0.884</td>
</tr>
<tr>
<td>5</td>
<td>0.876</td>
</tr>
<tr>
<td>5</td>
<td>0.862</td>
</tr>
<tr>
<td>5</td>
<td>0.88</td>
</tr>
<tr>
<td>4</td>
<td>0.905</td>
</tr>
<tr>
<td>4</td>
<td>0.961</td>
</tr>
<tr>
<td>3</td>
<td>0.98</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
Conclusion

The results suggest that the spatial relationship is able to estimate the existence of cooperative activities between students, and is able to be used for online student state detection.

In our future work, students’ posture, gesture and verbal data are going to be involved. Interaction between students should be considered as well.
References

Jean Piaget (1953). The Origins of Intelligence in Children.


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Rethinking the Promise Of SCRATCH In the Applied Linguistics Classroom: Students’ Perspectives, Instructor’s Observations

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Abstract
For five fall semesters (2010-2014), undergraduate and graduate students taking applied linguistics (LN400, LN500) at the University of Guam were required to explore the promise of SCRATCH by designing projects relevant to their individual fields of specialization, from language teaching and literature, to pragmatics and sociolinguistics. SCRATCH, a free downloadable program from MIT (Massachusetts Institute of Technology), enabled them to think of creative ways to teach or transmit relevant information to their audience, as well as learn the rudiments of programming. At the end of the semester, each student was required to submit a CD Rom and paper discussing the relevance of the project to theories of second language acquisition or other relevant fields. This presentation will discuss the value of SCRATCH in the applied linguistics classroom by summarizing five semesters’ worth of students’ comments about and evaluations of the program, and the instructor’s observations and assessments of students’ SCRATCH projects.
Introduction

In the 21st century, computers, Androids, iPads, iPhones, and even iWatches and their equivalents have become such part and parcel of almost everyone’s everyday lives that effective educators must make technology integral to their teaching as well. Students use iPads, Tablets, iPhones, Androids, and decreasingly, computers (too big, too bulky), to take notes, to verify information, to do research, to stream, to watch shows and movies, to play games, to socialize: to chat, to Twit(ter), to Instagram (the last two are used as nouns and verbs). If teachers allow it, many students in their classes distractingly tinker with or sneakily check their Androids and iPhones several times during class (and perhaps anywhere else they may be). Two and three-year-olds learn to use the iPad at the same time as the fork and spoon. All these imply that every cutting-edge professional and educator must make use of these technological devices to enhance learning. They must find ways to make their students’ favorite inseparable tools, toys, and gadgets that use technology—contribute to better teaching and better learning. The programming tool SCRATCH is an example of a promising classroom tool. For five Fall semesters, undergraduate and graduate students of Applied Linguistics (LN400, LN500) at the University of Guam were required to design SCRATCH computer projects for possible use in the classroom, for students of different ages and levels of competency. After becoming familiar with second language learning/acquisition theories in the first half of the semester, applied linguistics students were required to think of ways to integrate SCRATCH into possible classroom lessons in foreign language teaching and the teaching of other content areas. They were told that their projects had to reflect their creativity, imagination, (multi-)cultural/ethnic sensitivity, knowledge of second language/learning theories, and teaching ability.

SCRATCH

Why use SCRATCH in the applied linguistics classroom? SCRATCH is a relatively simple computer language that was originally designed to teach children the basics of programming in a simple, creative, fun, logical drag-and-drop way. But children are not the only ones who can benefit from the program. It enables anyone of any age to do simple-to-complex graphics, animation, interactive games, with or without music and sounds—the possibilities are endless. This free and downloadable program consists of a sprite (and other) characters, as well as a list of commands that can be used in any project. All commands are listed along the side of the program in the form of puzzle or lego-like pieces that can be added to the script. Developed by MIT Media Lab’s Lifelong Kindergarten Group, with support from organizations and businesses like the National Science Foundation, Microsoft, Google, and Intel, SCRATCH was designed to stimulate and encourage anyone interested, from children to adults, not only to think critically, logically and creatively, but also to work collaboratively. Posted sample programs and tutorials on the net can be invaluable to those who wish to learn using the program. Fall 2010, 2011, and 2012 applied linguistics students used SCRATCH Version 1.4; Fall 2013 and 2014 students used the new Scratch 2.0 version. It was hoped that the new version would take care of the difficulties students had with the earlier version.
Applied Linguistics at the University of Guam (LN400/LN500) is a one-semester undergraduate/graduate course that English as a Second/Foreign Language (ESL/EFL), and English-language/linguistics track majors must take. It is an optional course for other education majors since the School of Education and Division of English and Applied Linguistics are separate units at the university. Although the course surveys the main subfields of Applied Linguistics, the first half of the semester covers second language acquisition theories, e.g., Cross-linguistic Influence or CLI (Kellerman 1995, Odlin 2003) – the weak version that remains from the controversial Contrastive Analysis Hypothesis (Lado 1957); Krashen’s (1981, 1982, 1983, 1985, 1997) theory with its bundle of five hypotheses – Monitor, Acquisition vs. Learning, Affective Filter, Input i+1, and Natural Order Hypotheses; Cognitive Theory and Approaches (McLaughlin 1987, Scovel 1999, R. Ellis 1997; q.v., Mitchell, Myles, Marsden 2013); Social Constructivist Theories (Long 1996, 2003); Inter/Intralanguage/Fossilization Theories (Selinker & Lamendella 1979, Long 2003); Linguistics/Universal Theory (Chomskyan) and Functional Approaches (q.v., Mitchell, Myles, Marsden 2015). Applied Linguistics students were expected to link any one or any combination of these theories with their SCRATCH projects.

Communicative Competence

Two previous papers (Quan 2013, 2014) proposed a model of the relationship between L2Acquisition theories and communicative classroom methods in the applied linguistics class projects based on Hymes’ (1974) notion of “communicative competence”. Below is a modified version of the model:

COMMUNICATIVE COMPETENCE IN A FOREIGN/SECOND LANGUAGE CLASS

Fun, Engaging, Practical Activities

L2Acq.THEORIES ↔ COMMUNICATIVE CLASSROOM METHODS ↔ Lesson Plans & Tools

Included: TASK-BASED
Linguistics: Phonology, Morphology, Syntax
Content area learning/teaching
Culture, social learning/teaching
4skills: Speaking, Listening, Reading, Writing
Rhetoric

Teachers evaluating the effectiveness available programs/tools

H.D. Brown (2007) enumerated some characteristics of an ideal communicative language teaching classroom (cf. Hymes 1972 on communicative competence). They include the need for the following: A) cultural, social, as well as linguistic competence since it is never enough to speak in grammatical sentences. Learners must also conform to the social and cultural norms of the speech community. This means that grammatical errors are more forgivable than social ones. For example, a monk cussing in the temple will entail serious consequences; the same monk committing a subject/verb agreement error will not; B) authenticity and functionality in lesson design because a speaker should sound natural and what he is taught must have practical uses; C) the necessity of sometimes sacrificing grammatical accuracy for fluency, or “getting the point across” for successful communication, especially in the early stages. A speaker who consults a dictionary for every word he wants to communicate will end up losing the attention of his listener who may ignore him in irritated impatience. The message is sometimes more important than the correctness or grammaticality of the message. D) the need to develop students’ ability to actually
be able to function in real-life situations, in the target language setting, beyond the classroom. One traditional, perhaps extreme trial by fire assessment activity was developed by Dartmouth College’s John Rassias in the 1970s, which left the learner in the middle of nowhere in the target language (monolingual) speech community with little or no money. The learner had to find and his way to a particular destination with no choice but to negotiate his way using the target language.

To Brown’s list, I add three more characteristics of an ideal L2 communicative classroom: E) the need for positive rapport between students and between students and the teacher in the language classroom, to facilitate language learning/acquisition in the foreign language. A positive environment contributes to positive attitudes, openness, lack of fear in making mistakes, the formation of new friendships and possibility of collaboration, in the language classroom. F) the goal of decreasing the role and power of the teacher from sole informant, to guide, to minor guide, in order to prepare students for the target language real-life environment; and, G) the acceptability of using the native language(s) to teach/learn the target language, at least in the early stages, to relieve tension and fear, and facilitate acquisition.

The first year of the SCRATCH 1.4 project in the Applied Linguistics classroom was exploratory and collaborative, with each group of 3 or 4 students submitting one project. In the second through the fifth Fall semesters, every student was required to program his or her own project, although students were encouraged to work in groups to help each other out, or for “knowers” to help others. In the second year, a student from the previous year was invited to speak to the class, give advice, and answer questions about the program. This knower-helping-novices approach apparently helped students a lot. From Fall 2013, students used the newest version of Scratch (2.0) to plan, prepare and submit their individual projects.

In the course of five semesters, criteria for evaluating students’ projects have been developed (Quan 2013, 2014). They involve examining how the individual projects tie in with the theories of foreign language acquisition and communicative learning methods, or with other content areas for non-education majors. At the end of the semester, students had to submit CD or thumb drive copies of their projects. Additionally, just as the teacher assessed students’ individual projects, students were, in turn, required to submit narrative summaries to evaluate / assess their learning experience with the SCRATCH program and its possible usefulness/value in the foreign language class and other content areas. Education majors had to submit a lesson plan integrating their SCRATCH project into the learning objectives for their students. The most important question they were asked to address was, as present and future teachers, would they use SCRATCH in their classrooms? Most of them, replied in the affirmative.

Below are two tables enumerating students’ positive and negative comments about their overall experience with their projects. In the first table, students of Fall 2010, 2011, and 2012 describe their experience with the SCRATCH 1.4 program. In the second, students of Fall 2013 and 2014 comment on their experience with the new SCRATCH 2.0 version.
UOG Applied Linguistics Students’ Evaluations of SCRATCH 1.4
2010-2012

<table>
<thead>
<tr>
<th>POSITIVE COMMENTS</th>
<th>NEGATIVE COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fun!</td>
<td>1. Very time-consuming</td>
</tr>
<tr>
<td>2. Great learning experience</td>
<td>2. Not easy to use/learn in the beginning</td>
</tr>
<tr>
<td>3. A useful tool for educators who want a different teaching method in the classroom</td>
<td>3. Hard to coordinate sounds, movements</td>
</tr>
<tr>
<td>4. A creative alternative to Powerpoint, lectures, chalkboards, with the teacher talking all the time!</td>
<td>4. Takes a few days to learn and feel comfortable with the program</td>
</tr>
<tr>
<td>5. Allows teachers to be very creative</td>
<td>5. UTube videos and tutorials were too basic</td>
</tr>
<tr>
<td>6. Middle and high school students can use SCRATCH to do presentations, have fun, create games themselves</td>
<td>6. Commands are hard to learn; challenging for teachers who are not programming-savvy!</td>
</tr>
<tr>
<td>7. No limit as to what it can do</td>
<td>7. Takes a lot of patience and time that teachers may not have</td>
</tr>
<tr>
<td>8. A useful tool for ESL/EFL students as well as native speakers of English</td>
<td>8. What if classrooms don’t have computers?</td>
</tr>
<tr>
<td>9. Teachers placed on the cutting edge of technology!</td>
<td>9. What if students don’t have computers at home?</td>
</tr>
</tbody>
</table>
**UOG Applied Linguistics Students’ Evaluations of SCRATCH 1.4**
**2013 - 2014**

<table>
<thead>
<tr>
<th>POSITIVE COMMENTS</th>
<th>NEGATIVE COMMENTS</th>
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<tbody>
<tr>
<td>1. Fun! Interactive! Keeps kids engaged!</td>
<td>1. Time consuming; Very tedious (2014)</td>
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<tr>
<td>2. An inspiring tool – promotes learning</td>
<td>2. Confusing and intimidating in the beginning, esp. for those starting from scratch</td>
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<td>3. Versatile tool for teaching anything, not just ESL/foreign language</td>
<td>3. Must coordinate sounds, movements, bubbles/conversations to minimize overlaps/interference</td>
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<td>4. Availability of tutorials, as well as a sprite library for resources</td>
<td>4. Takes a few hours to a few days to learn and feel comfortable with the program</td>
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<td>5. Ease of recording audio material</td>
<td>5. Even minor editing means watching the entire presentation from the beginning, for timing &amp; aesthetics</td>
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<td>6. A good tool for incorporating technology into the classroom</td>
<td>6. Hard to coordinate sprites, backgrounds, functions, sounds</td>
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<td>7. Scratch 2.0 has tutorials for every one of its 10 steps posted on website</td>
<td>7. Program lacks a conventional playback method; “snapping” feature was annoying</td>
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<tr>
<td>8. A great teaching tool for teaching anything; a useful program for teaching students and teachers of all ages</td>
<td>8. Problems with the Costumes tabs: enlarges the character; must restart program to fix problem – a waste of time!</td>
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<tr>
<td>9. Can integrate any outside photo/drawing into the program</td>
<td>9. Speech bubbles of characters can cover other characters in the program. Can this be prevented?</td>
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<td>10. Availability of sample programs from the website and YouTube to help w/ programming &amp; ideas</td>
<td>10. A minor change in the program entails playing the entire program to coordinate timing</td>
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<td>11. Problems, questions, and difficulties not addressed by the Scratch website are Googleable</td>
<td>11. Program’s tutorial voice sounded bored and boring</td>
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<td>13. Program can give immediate</td>
<td>13. As scripts expand, program becomes</td>
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virtual feedback
slow to navigate; must be broken into sets

14. It enables kids & adults to learn programming
14. Not everyone is interested in programming

15. A useful bridge to other programming languages

16. An innovative way to teach digital literacy

17. A new teaching style for teachers, a new learning style for students.

Applied Linguistics Instructor Observations

1. For students, the process of designing the SCRATCH project is not linear. Based on five years’ observation, the steps for many student teachers appear to be: a) Downloading Scratch b) Tinkering with the program for familiarization c) Looking at tutorials for guidance; d) Manipulating very simple programs; e) Planning, designing their personal project: topic, content, characters, layout, backgrounds; f) Looking for possible tutorials and other sample programs from the Scratch website, YouTube, or Google that loosely match what they aim to do; g) Writing the program; h) Editing, correcting, modifying, simplifying, adding on; i) Going back and forth (b through h); j) changing the program if necessary and starting over; k) testing the program many times.

2. SCRATCH project comprises 30-40% of the final grade in LN400/500. Should assessment be based solely on the finished product regardless of student’s previous programming background experience or lack thereof? OR should the instructor be more understanding: more demanding of those with the background, and more forgiving of those without? After 5 semesters, instructor can recognize projects that were done last-minute, and hurriedly, regardless of background.

3. Collaborative work works! Each student had his/her own individual project, but it helped to work collaboratively when learning the rudiments of SCRATCH programming. It helped to have a “knower” from a previous semester answer students’ questions about their own personal project.

4. Extra pressure made for better work: the University of Guam Language Arts Conference presentations prodded students to work faster, and better.

5. In the 5 semesters that SCRATCH was required, students’ projects were determined by their fields of specialization or interest. Education majors had no choice but do a SCRATCH project with lesson plan; literature, linguistics, anthropology and other majors designed projects related to their fields.

6. Several of my adult students claimed that when stuck, their high school-age children helped them with their projects! Is it easier for kids to learn SCRATCH than
adults? In Fall 2014, one student commented that the project was very tedious; three other students echoed the same sentiment in their papers, using the same word!

7. Among issues to be addressed are copyrighted materials. If teachers use Disney or Star Wars characters in their projects, for example, what do copyright laws require? What are the possible negative consequences if they were to post these projects online, for example? Do they have to invent their own characters instead of borrowing characters the audience is already familiar with, like Princess Leah, R2D2, Hello Kitty, or Dora the Explorer?

8. The most promising value of SCRATCH in applied linguistics lies in its versatility. It allows teachers to LOCALIZE and personalize the teaching material. Instead of “imported” predesigned non-local based exercises and activities, teachers can tailor lessons to fit the students’ learning styles and cultural backgrounds/settings. This just may lead to more effective learning!

9. As with any kind of writing, students must constantly keep the Audience and the Purpose of their projects in mind.

Conclusion

Applied Linguistics students at the University of Guam will continue using SCRATCH in their projects and will continue presenting them at the university’s annual language arts conference, if possible. The versatility and the timely upgrading of the program to make it more user-friendly for children and adults place it in the cutting edge of basic programming and teaching. SCRATCH is one of the tools that teachers can use to enhance and reinforce language learning as well as learning in the other content areas. Its simplicity is its strength because it makes the program accessible to those without any previous background in programming. Its “cartoon” characters make it (and therefore also the process of programming) less intimidating to children and adults alike. For applied linguistics students, the SCRATCH project promises to hone their critical thinking, imaginative, and creative skills in teaching and learning.
Appendix A
Sample Screen Shots of Students’ Work
References


Lifelong Kindergarten Group, MIT Media Lab (2013). SCRATCH 2.0 (programming language).


Designing Science Simulations in Accordance with Research-Based Guidelines:
A Case Study Approach

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Abstract
The applicability of evidence-based guidelines in the design of complex science simulations for a popular online astronomy course is considered in the current paper. Science simulations pose a number of challenges as they tend to deal with complex and/or counter intuitive information, require the manipulation of inter-related parameters and thereby often presume a significant level of expertise from the learner. Through a collaborative approach involving a content-expert, several programmers and an educational multimedia specialist the team were able to more effectively co-design and re-design the simulations to minimise the cognitive load placed upon the student and thereby facilitate more efficient learning.

In terms of the layout of specific elements within the simulations the production process considered the optimal utilization of signaling techniques such as arrows and highlighting and also maximised spatial and temporal contiguity between disparate sources of information in order to minimise any split attention effect. In some cases, the presentation of complex and/or novel information necessitated pre-training in the form of a short audio-visual explanation so as to avoid a mismatch between the learner’s level of prior knowledge and skills and the demands of the learning task. Consideration was also given to exemplifying the use of the simulation interface by way of a worked example in cases where it was deemed that the task was sufficiently complex or ambiguous.

The simulations themselves were embedded within an online adaptive learning environment that was supplemented with self-paced lecture material containing both textual and visual elements.

Keywords: multimedia, simulations, animations, astronomy, cognition, evidence-based guidelines.

Introduction

The teaching of science often requires the communication of complex or counter-intuitive concepts that can be troublesome to the student cohort (Meyer and Land 2003). The assimilation of such knowledge structures is often facilitated through the use of visualizations ranging from static images, animations and videos through to multi-parameter simulations. Here, we consider the collaborative design of interactive simulations and their subsequent incorporation into an adaptive e-learning environment within the context of an online astronomy course.

The course we are currently upgrading is a popular fully online course that enrolls more than two thousand students per year over three semesters. It provides an introduction to astronomy and the search for life in the universe at a non-mathematical level. The majority of students who take the course are non-science majors. As part of the upgrade we are building tutorial and assessment activities using the Smart Sparrow Adaptive eLearning Platform™.

The tutorial activities were largely built around scientific simulations. Research based multimedia principles (Mayer 2008) guided the design process of the simulations and also assisted the team to judiciously incorporate static images and/or audio-visual material to further support the simulation-based learning activities.

Multimedia design considerations

The relative merit of using static images or dynamic animations for teaching and learning has been regularly investigated by educational psychologists over the last two decades (Mayer 2009). The research reveals that, counter to common belief, dynamic visualizations are often no better than static images for the purposes of student learning (Höffler and Leutner 2007). This finding has been attributed to the inherent transience of animations (Sweller, Ayres et al. 2011) and researchers have endeavored to determine the conditions under which this effect can be ameliorated. As such a number of evidence-based guidelines have been formulated to guide practitioners in the layout and presentation of multimedia material such as stills, animations, videos and simulations (Mayer and Moreno 2003).

Unlike stills and animations, which typically incorporate minimal or no interactivity, simulations often require the student to manipulate inter-related parameters to achieve the learning objective. With regard to science-based simulations in particular, both the inherent complexity of the information and the associated interactivity add considerably to the cognitive load placed upon the student’s processing abilities. Consequently load-reducing strategies incorporated into the design and embedding of simulations are critical in working to ensure that the student’s cognitive resources are not overwhelmed.

In order to design multimedia resources such as complex simulations for optimal student learning it is essential to understand how a number of factors relating to cognition, prior knowledge and user-control can guide the practitioner in determining the layout and presentation of the subject material.
Human Cognitive Architecture

The assimilation and processing of information through audio visual channels has been shown to be limited by working memory both in terms of capacity and duration. Without mental rehearsal working memory can only hold around seven items (such as digits, letters etc.) for mere seconds (Miller 1956). As such meaningful learning, through the encoding of information into long term memory, can only occur if working memory has sufficient time to rehearse the necessary knowledge structures. The processing of information through this “bottleneck” created by working memory limitations can be better facilitated through the optimization of design considerations affecting the layout, such as the presence of signaling cues and the minimization of any split attention effect incurred by a lack of spatial and temporal contiguity (Kalyuga, Chandler et al. 1999, Mayer 2005). The content expert and multimedia designer can also collaborate to ensure that sufficient levels of prior knowledge have been attained by the learner through pre-training activities (Mayer 2005b) and thus ensure there is no significant mismatch between the students processing abilities and the cognitive load imposed by the learning activity. Prior knowledge structures already encoded into long term memory, referred to as “schemas”, provide a framework that enables working memory to more easily identify and assimilate incoming information.

In particularly complex simulations the student may further be assisted by the presenter “test driving” the simulation to demonstrate a typical scenario in terms of manipulating parameters to achieve a desired learning goal. This is akin to providing a worked example (Sweller 2006) and has been shown to be valuable in terms of modelling to the learner a particular strategy so as to engage with the interface in an effective manner (Hatsidimitris and Kalyuga 2013).

All the above design strategies work together to lower the cognitive load placed on working memory and thereby allow for an optimal learning experience.

Designing the simulations

The simulations are initially designed collaboratively between the content expert and the HTML5 programmer. The draft is then sent to the educational multimedia specialist who considers how research based principles may be incorporated into the design and subsequently makes a number of recommendations to the content expert and programmer. If the proposed amendments to the design “make sense” and do not require inordinate amounts of time to implement then a revised simulation will be created.

The guidelines most often considered were those that minimise the split attention effect i.e. spatial/ temporal contiguity principles and also the signaling principle, which basically informs the learner where they should direct their visual attention at any given point in time. Signaling is particularly important in complex visualisations as research has shown that novices tend to focus their attention on what appears “perceptually salient” rather than that which is “thematically relevant” (Lowe 2008).
In Fig.1 the interactive multimedia requires the learner to sequentially drag the small thumbnail pictures to the correct location along the timeline. As the timeline covers many millions of years there is a slider to allow the learner to scroll across the entire historical timeline of the universe since the “big bang”. In the initial draft the slider was not indicated by a semi-transparent red layer and so this visual cue was added as a signal to indicate a key point of interactivity. Further to this, in the initial draft a correct solution only entailed a textual response of “correct” but it was later decided that it could also be accompanied by a short textual summary of what the time-event entailed. Presenting this factual material within this context provided for temporal contiguity as the learner didn’t need to recall knowledge that may have only been acquired beforehand from the online lessons.

![Timeline of Life on Earth](image)

**Fig. 1 Interactive “Timeline of Life on Earth” activity had multimedia principles applied in a simple but effective manner.**

**Embedding simulations within the broader learning context**

The multimedia designer can consider the applicability of design principles that reflect the general limitations of human cognitive architecture. This is referred to as reducing extraneous cognitive load (Sweller 2010). However, in any given learning activity it is the content expert can avail themselves of multimedia guidelines that serve to minimize any mismatch between the difficulty and complexity of the material and the current state of the student’s skills and prior knowledge. This strategy is referred to as reducing intrinsic cognitive load (Ayres 2006) as it is particularly concerned with the level of difficulty inherent in knowledge structures as perceived by the student, given their level of prior knowledge. In this case the teacher can best gauge the need for incorporation of principles such as segmentation and pre-training to enable the student to more effectively learn new or complex information.

The segmentation principle operates on the basis that intervals between small segments of information will allow the user more opportunity to process the information than one continuous stream of information (Ali and Madar 2010). This principle is evident in the interactive tutorials in so far as they are composed of
series of self-paced “slides”. Segmentation is usually most beneficial when information is in the form of a particularly extended text, video or animation. However, in the case of simulations per se the user initiates and controls changes in the state of the visuals through the self-paced manipulation of parameters and as such the segmentation principle need not be applied. Nevertheless the complexity inherent in the inter-related manipulation of several parameters lends itself to a multitude of combinations and so pre-training can provide crucial information to guide the learner’s strategic use of the interface.

The pre-training principle basically states that the learner would use their time more efficiently when encountering complex information such as found in animations, videos and simulations if they were first instructed to identify and understand the key elements. In conjunction with this principle is the guideline advocating worked examples as a means of modelling or demonstrating to the student a particular strategy to adopt in solving on or more problem states (Sweller 2006). Research by Hatsidimitris and Kalyuga (2013) further demonstrated that providing a worked example to students regarding the efficient use of an interface in a recall task resulted in significant increases in the overall student performance. Keeping these principles in mind the project team are working towards providing a level of pre-training that not only sequentially introduces various elements of the simulation but that also seeks to exemplify a strategic use of the interface in order to achieve a required inter-relationship of parameter settings. This two-fold approach i.e. introducing the various onscreen elements and then demonstrating the simultaneous manipulation of parameters to achieve a learning goal is particularly relevant to the more complex scenarios evident in some of the simulations.

**Conclusion**

The collaborative design and production of educational simulations requires team members with expertise with respect to the subject matter, design principles and the logistics and costs of graphics-based software and programming languages. At the “micro” level one needs to evaluate the simulation in terms of its layout and implement revisions, particularly in terms of signaling and spatial contiguity, so as to lower the cognitive “hurdle” imposed by the learning task. At the “meso” level one must ensure that particularly complex simulations are accompanied with pre-training that introduces the various elements and, where deemed necessary, a demonstration of how to manipulate the parameters to achieve a “critical” state or inter-relationship. At the “macro” level the simulations, if provided as an assessment task, need to be supported by corresponding background information in the lesson material and should reflect the overall key learning objectives of the course. In an ideal world, given the cost and resources involved in generating simulations, the teaching resources should be both downloadable and re-usable in different learning environments.
References


