An Explanatory Sequential Study on Indonesian Principals’ Perceptions on ICT Integration Barriers

Lantip Diat Prasojo¹, Akhmad Habibi², Mohd Faiz Mohd Yaakob³, Amirul Mukminin², Septu Haswindy⁴ and Muhammad Sofwan²
¹Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
²Universitas Jambi, Jambi, Indonesia
³Universiti Utara Malaysia, Kedah, Malaysia
⁴Research and Development Agency of Jambi Province, Indonesia

lantip1975@gmail.com
akhmad.habibi@unja.ac.id
mohd.faiz@uum.edu.my
amirul.mukminin@unja.ac.id
d34r.w3ndy@gmail.com
muhammad.sofwan@unja.ac.id

Abstract: This explanatory sequential study investigated secondary school principals’ perceptions on barriers regarding the Information and Communication Technology (ICT) integration in a developing country, Indonesia. For the quantitative phase, we administered a survey instrument to 250 Indonesian secondary school principals. The survey instrument was developed based on previous related literature validated through content validity and piloted before being distributed. Following the quantitative process, three Focus Group Discussions (FGDs) with 30 participants were conducted to obtain more in-depth information. Each FGD was attended by 10 participants. The findings revealed that the most highly identified barriers are ICT, traditional teaching style, professional development, as well as district and school culture. Recommendations are offered for the improvement of technology integration for educational purpose.

Keywords: barriers, Indonesia, technology integration, secondary school principals, developing country

1. Introduction

In teaching, the role of technology is currently transforming and is becoming one of the most important influential factors. The role has been widely discussed in some current educational policy studies (Charbonneau-Gowdy, 2018; Nortvig, Petersen and Balle, 2018). If technology had been properly integrated in instructional activities, it would have led to great expectation in the improvement of teaching and learning, and shaping opportunities for future workforce (Mishra and Koehler, 2006). Through the history of technology integration, technology illiteracy is now considered as the new form of illiteracy (Rosen and Michelle, 1995). This fact has lead policy makers in every country in the world to gain a new strong intention and effort to equip schools and universities with Information and Communicating Technology (ICT) infrastructures such as computers and internet access as well as providing qualified staff, teachers and administrators to produce quality students as the next generation who are proficient in technology use for every opportunity in the future. There is no dispute that computers and internet use have been able to aid the teaching and learning process as well as to provide proper opportunities to facilitate students’ learning. Many studies have underlined positive integration effects of technology in instructional processes (e.g. Ertmer and Ottenbreit-Leftwich, 2010; Deng, et al., 2014; Kimmons, et al., 2015).

In addition to the positive effects of integration, breaking down barrier should also be considered and any strategy that seeks to change teaching practice should consider the social and cultural context of the school organization (Hargreaves, et al., 2001; Tondeur, et al., 2009). One common issue when implementing new strategies with ICT is that the stakeholders tend to focus on adopting the technology, without providing the appropriate conditions for the social and cultural learning that is required for such an innovation (Hargreaves, et al., 2001). Among these circumstances, all school members who are involved should adopt a common approach, including school administrators or principals. This common approach includes their perception towards barriers of ICT integration in an educational setting (Alghamdi and Prestridge, 2015).
For school administrators, the logical approach is one of the most vital things regarding barriers of ICT integration in schools. The principals are very important in creating the conditions required for a school reform to be finally beneficial for ICT integration (Hargreaves, et al., 2001; Korumaz, 2016). Studies have revealed that principals who have capacities in supporting and guiding their school teachers in technology integration in teaching practice obtain a clear vision of how the technology will contribute to improving projects in shaping the ways students learn in current technological development in education (Chang, 2012; Korumaz, 2016). The school principals’ involvement in the integration of technology is crucial for the programme’s sustainability. Fewer studies were conducted to investigate school principals’ perception towards ICT integration more especially in developing countries (Tondeur, et al., 2009). Therefore, this current study was conducted to comprehensively understand barriers experienced by secondary school principals regarding technology integration in education in Indonesia as one of the developing countries. The two guiding questions are:

1. What and how are ICT integration external barriers perceived by Indonesian secondary school principals?
2. What and how are ICT integration internal barriers perceived by Indonesian secondary school principals?

2. Literature review

2.1 Barriers of ICT integration

Challenges towards ICT integration have been inspiring educational researchers to cover and overcome the barriers to produce successful ICT integration into teaching (Ertmer, 1999). Barriers to ICT integration was defined as conditions which provide difficulties to the successful process of ICT integration in educational setting (Ertmer, 1999; Bingimlas, 2009; Koh, et al., 2013; Tsai & Chai, 2012). Researchers have discussed barriers in ICT integration in various ways, conditions and settings however, two underlined classifications consistently were categorized as external barriers (resources and institutions) and internal barriers (teachers and their attitudes). In early studies, Ertmer (1999) described these barriers with terms of first-order and second-order to ICT integration. She discussed first- and second-order barriers as a comparison to evaluate teachers’ integration of ICT in an elementary school (Ertmer, 1999). While researchers such as (Bingimlas, 2009; Koh et al., 2013) hypothesized that the barriers interact in various ways however, there has been no evidence to show which barriers are the most influential in ICT integration into instruction.

2.2 External barriers of ICT integration

Studies have revealed that the external or original first-order barrier of ICT integration, having access to computers and the internet, has been lifted in almost every public school classroom in developed countries (Gray, Thomas and Lewis, 2010). However, in developing countries such as Indonesia, the barrier regarding computer and internet facility is still prevalent (Habibi, et al., 2018). In addition, some teachers state that limited access to computers and internet is still a main barrier to full integration of ICT (Cuban and Jandric, 2015). Other external barriers are inferior hardware or software, limited peer, and technical support, lack of training and a lack of time to improve skills to use computers and the Internet (Ertmer, Ottenbreit-Leftwich and York, 2007; Kim, et al., 2013; Kilinc, Tarman and Aydin, 2018). Researchers in educational technology have revealed that these barriers will probably always emerge with the changing of technology including innovation and development as well as the current design of the school system (Hermans, et al., 2008). Reducing first-order barriers or external barriers requires costly funding and the reforming of pre-service teacher training models at university level (Ertmer, et al., 2012; Lim, et al., 2013; Machado and Chung, 2015).

2.3 Internal barriers

In addition to external barriers, researchers have found that second-order barriers or internal barriers are more difficult to overcome (Alkhawaldeh and Menchaca, 2014; Collins and Halverson, 2009; Cui and Vowell, 2013; Ertmer, et al., 2012). For example, teachers as practitioners in the teaching and learning process were found to have many external or first-order barriers, as well as personal or second-order barriers (Alkhawaldeh and Menchaca, 2014; Ertmer, et al., 2012). Even those who have had positive attitudes towards ICT integration would eventually develop negative attitudes towards ICT integration because of the first-order barriers they found (Collins and Halverson, 2009). The most common second-order barriers include pedagogical beliefs, motivation, established practices and cultures and personal beliefs about computers (Ertmer, et al., 2012; Mueller, et al., 2008).
3. Methodology

This study was a sequential explanatory design characterized by the collection and analysis of quantitative data in the first phase of the research, followed by the collection and analysis of qualitative data in the second phase (Brannen, 2005; Creswell 2014). A sequential explanatory strategy was used because this study sought to use quantitative research. To obtain further information about the results, the phase was followed by qualitative research (Brannen, 2005). This approach emphasized how the qualitative findings helped elaborate or extend the quantitative results (Creswell, 2014).

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3.1 Quantitative phase

We used survey design which provides numeric description using questionnaires for data collection. Survey research aimed to describe the situation and the characteristics of a population (Fraenkel & Wallen, 2009). The population of this study was more than 1000 secondary school principals in one Indonesia. Using random sampling, we distributed the survey instrument to 250 principals; however, only 210 principals returned the survey. Two hundred and one surveys were completed and assessed.

The first step in developing the barriers survey was to review relevant methods literatures instruments (Avidov-Ungar and Shamir-Inbal, 2017; Claro, et al., 2017; Kilinc, Tarman and Aydin, 2018; Serhan, 2007) that were already being used for assessing barriers of technology integration in educational settings. Most of these instruments focused on the way in which internal and external barriers were constructed regarding technology integration. All authors contributed in developing and revising every item in three sessions of discussion. Following the discussion, the instrument was sent to a panel of experts; three experts in educational technology and two experts with degrees in educational policy and management as part of a content validity process (Lawshe, 1975). Each expert was requested to rate the extent to which each question measured using a 10-point scale (with 1 being the least measure and 10 being the greatest measure). The experts were also asked to provide some comments and suggestions for each question and, in some cases, suggested their own possible question list for either internal or external constancy.

After being reviewed by the panel of experts, 32 items were set. However, six items were eliminated because they were not reliable after being piloted with 35 principals. The remaining 26 items were measured with a four-level likert scale: 1. Strongly disagree, 2. Disagree, 3. Agree, and 4. Strongly agree. In addition to the main instruments, demographic information namely gender, age, and experience, as well as educational qualification were also distributed. We collected the data through a printed questionnaire. After obtaining the data, we measured the consistency reliability or coefficient alpha (.79 for internal barriers and .86 for external barriers). According to George and Mallery (2001), the alpha is considered to be acceptable. We used descriptive statistics (Ross, 2010) measuring the mean and standard deviation of the research for the data elaboration.

3.2 Qualitative phase

After the analysis of the quantitative data, Focus Group Discussions (FGD) were conducted to obtain in-depth information regarding barriers in ICT integration using a case study (Creswell, 2014; Stake, 1995). Creswell (2014) argued that a case study is appropriate if the researcher wants to produce a high-quality theory because a single case study explores and creates deeper theories. He also stated that the researcher would have better understanding of the explored object namely the research. Choosing a qualitative case study approach in this sequential explanatory design was in order that the findings of this study might not be generalized in the other places or participants (Creswell, 2014).

During the distribution of the survey instrument, we asked the respondents to fill in an availability form confirming whether they were willing to attend the FGDs. Fifty-seven respondents agreed to participate. However, only 30 participants were chosen. The choice was made regarding the representative area, financial matter, and other important factors (Fraenkel and Wallen, 2009). We masked participants’ name in symbols (P1-P30) in the data presentation to protect their privacy (Creswell, 2014). The chosen participants were
contacted by phone calls and short messages and asked to come to the FGD sessions. All costs including transportation, accommodation, and consumption were paid by the authors using the research funding. The FGDs were divided into three sessions; each FGD was attended by 10 participants. Discussions lasting about 120 minutes were recorded and video-taped. The survey instrument provided the set of guiding questions for the semi-structured discussion or interview. Semi-structured questions were applied to understand how some interventions work and how they can be improved. This allows interviewers to discuss issues that may not be considered (Creswell, 2014). During the FGDs, the participants were free to argue but limited to certain rules introduced at the beginning of the discussion. We used Google docs Voice Typing to transcribe the recording, an online application for data transcription that needs clear sound in the process.

We analyzed the data using within-case and cross-case analysis that consists of thematic conceptual-ordered analysis, causal network analysis, and partially ordered analysis (Stake, 1995). We processed the data analysis with equal methods although the participants’ background and experience varied. The first activity that the researchers did after obtaining the data from focus group discussion was to transcribe the data. Using the latest invention from Google, the data was processed through Google docs voice typing. The next step was to compile this transcription. After compiling the data, we printed the files in order to examine the data. We read and re-read the transcripts to highlight and examine any connections and omissions. This activity was lead by one of the researchers. The coding was manually done followed by the translation process which resulted in themes and sub-themes. In relation to the research aim, we focused on the topic in accordance with the survey results; to discover any emerging information in line with the barriers of ICT integration from the principals’ perspectives.

To ensure the trustworthiness of the study, we included verbatim examples from the transcribed interviews (Lincoln and Guba, 1985). We also carried out member checking (Creswell, 2014). We checked not only all participants of the FGDs but also all co-researchers serving as member checking. In this stage, we returned all the data of the FGDs and our findings to all participants in order to get their feedback and agreement. This step was taken to ensure that our data presentation was without bias. All participants of the FGDs gave consent for us to use the data for our study.

4. Findings

Two hundred and one measurable responses were received out of 250 distributed printed questionnaires, of which, male samples almost quadrupled female samples. The largest age group was 40–50 years, accounting for 43.28%. Regarding the educational qualification, most of the participants (62.69%) graduated from postgraduate schools, Masters levels. Only one of them was Doctor of Education. Ninety-three participants had experience from 1 to 10 years in being a school principal. Only 7 participants had experience of above 30 years. Table 1 shows the detailed sample demographics.

| Table 1: Demographic questionnaire (n. 201) |
|---------------------------------|-----------------|--------------|
| Information                      | Frequency | Percent (%) |
| Gender                          |           |             |
| (1) Male                        | 164       | 81.59       |
| (2) Female                      | 37        | 18.41       |
| Age                             |           |             |
| (1) Below 30                    | 2         | 1           |
| (2) 30-40                       | 48        | 23.88       |
| (3) 40-50                       | 87        | 43.28       |
| (4) Above 50                    | 64        | 31.84       |
| Experience as school principals |           |             |
| (1) 1-10                        | 93        | 46.27       |
| (2) 11-20                       | 79        | 39.30       |
| (3) 20-30                       | 22        | 10.95       |
| (4) Above 30                    | 7         | 3.48        |
| Educational qualification       |           |             |
| (1) Undergraduate               | 74        | 36.82       |
| (2) Master                      | 126       | 62.69       |
| (3) Doctoral                    | 1         | 0.48        |
4.1 Quantitative phase

To explore school principals’ perceptions on ICT integration barriers, we calculated descriptive statistics (frequency, percentage, mean, and standard deviation) for each item. In the survey, we included items from an external barrier perspective (Q1–Q14) and an internal perspective (Q16–Q26). Table 2 depicts the frequency and percentage for each answer and the mean and standard deviations for each of the 14 indicators of external barriers. Based on the mean scores, principals agreed in most statements, for example, “professional development courses provided by the authorities were irrelevant to school needs for technology integration”, there is inability to provide computers in classroom, and there is no support to refresh programmes for older computers and other devices. However, some items seemed to have strong “disagreement” perception on some items such as “technology integration spends too much time for teaching”, “the school curriculum does not allow much time for technology integration”, and “the condition of classrooms is not suitable for integrating technology”.

Table 2: External barriers mean and SD

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
</tr>
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<tbody>
<tr>
<td>Professional development courses provided by the authorities were irrelevant to school needs for technology integration.</td>
<td>3.45</td>
<td>.53</td>
</tr>
<tr>
<td>There is inability to provide computers in classroom</td>
<td>3.45</td>
<td>.60</td>
</tr>
<tr>
<td>There is no support to refresh program for older computers and other devices</td>
<td>3.45</td>
<td>.61</td>
</tr>
<tr>
<td>There is no support from district authority for ICT needs</td>
<td>3.44</td>
<td>.61</td>
</tr>
<tr>
<td>The ICT is easily damage because the school culture is not supportive</td>
<td>3.41</td>
<td>.60</td>
</tr>
<tr>
<td>There is inability to provide Internet   in classrooms</td>
<td>3.41</td>
<td>.61</td>
</tr>
<tr>
<td>There is inability to provide Internet in school</td>
<td>3.38</td>
<td>.60</td>
</tr>
<tr>
<td>There is insufficient technical support to solve technological problems</td>
<td>3.29</td>
<td>.59</td>
</tr>
<tr>
<td>Technology integration requires too much time for teaching</td>
<td>2.15</td>
<td>.51</td>
</tr>
<tr>
<td>The school curriculum does not allow much time for technology integration</td>
<td>2.00</td>
<td>.64</td>
</tr>
<tr>
<td>The condition of classrooms is not suitable for integrating technology</td>
<td>1.98</td>
<td>.64</td>
</tr>
<tr>
<td>High-stake test restricts the use of technology</td>
<td>1.97</td>
<td>.56</td>
</tr>
<tr>
<td>Teachers cannot access softwares that they can utilize for their class</td>
<td>1.95</td>
<td>.60</td>
</tr>
</tbody>
</table>

Cronbach’s alpha .79

For the internal barriers (see Table 3), five statements were positively perceived by the respondents; “I think that the teachers in my school lack knowledge to integrate ICT with pedagogy”, “I think that the teachers in my school lack knowledge to integrate ICT with the content of the course”, I think that the teachers in my school lack confidence in using ICT”, and “I think that the teachers in my school lack knowledge of ICT use”. On the other hand, more than seven statements were negatively perceived, for example, “The integration of technology decreases students’ attention and concentration to the lesson”, “Technology integration limits teachers’ role in the classroom”, and “Technology integration makes teaching become more teacher centered”.

Table 3: Internal barriers mean and SD

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think that the teachers in my school lack knowledge to integrate ICT with pedagogy</td>
<td>3.78</td>
<td>.44</td>
</tr>
<tr>
<td>I think that the teachers in my school lack knowledge to integrate ICT with content of the course</td>
<td>3.68</td>
<td>.52</td>
</tr>
<tr>
<td>I think that the teachers in my school lack confidence in using ICT</td>
<td>3.60</td>
<td>.57</td>
</tr>
<tr>
<td>I think that the teachers in my school lack knowledge of ICT use</td>
<td>3.41</td>
<td>.61</td>
</tr>
<tr>
<td>The teachers preferred traditional teaching styles rather than using technology</td>
<td>3.30</td>
<td>.53</td>
</tr>
<tr>
<td>Technology integration makes teaching become more teacher centered.</td>
<td>2.03</td>
<td>.64</td>
</tr>
<tr>
<td>Item</td>
<td>Mean</td>
<td>SD</td>
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<tr>
<td>----------------------------------------------------------------------</td>
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<td>-----</td>
</tr>
<tr>
<td>I don’t believe teachers would know how to effectively integrate technology into the teaching process</td>
<td>2.00</td>
<td>.62</td>
</tr>
<tr>
<td>Rapid developments of technology makes me worried</td>
<td>1.94</td>
<td>.92</td>
</tr>
<tr>
<td>Technology integration make classroom management become less effective</td>
<td>1.87</td>
<td>.53</td>
</tr>
<tr>
<td>Technology integration limits teachers’ role in the classroom.</td>
<td>1.86</td>
<td>.66</td>
</tr>
<tr>
<td>Technology integration limits student centered learning.</td>
<td>1.83</td>
<td>.67</td>
</tr>
<tr>
<td>The integration of technology decreases students’ attention and concentration to the lesson.</td>
<td>1.83</td>
<td>.66</td>
</tr>
</tbody>
</table>

5. Qualitative phase

We presented all 30 participants’ responses in the focus group discussions to determine the sub-themes of the study. We categorized the sub-themes based on two main themes as previously discussed in the quantitative phase namely external barriers and internal barriers. We established the sub-themes identified by 50% or more of the participants in the FGDs. Four sub-themes for the external barriers and three sub-themes for internal barriers emerged from this study (see Table 4).

Table 4: Themes and sub-themes from FGDs about barriers of ICT integration

<table>
<thead>
<tr>
<th>Themes</th>
<th>Sub-themes</th>
<th>Number of participants</th>
<th>Frequency of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>External barriers</td>
<td>• Lack of funding</td>
<td>30</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>• Lack of professional development</td>
<td>25</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>• School culture</td>
<td>23</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>• District culture</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>Internal barriers</td>
<td>• lack of teachers’ knowledge of ICT and its integration for active learning</td>
<td>29</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>• lack of teachers’ understanding of ICT and its integration</td>
<td>29</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>• Traditional teaching styles</td>
<td>22</td>
<td>74</td>
</tr>
</tbody>
</table>

External barriers

There are four sub-themes for external barriers which include Lack of funding, Lack of professional development, School culture, and district culture. 75 responses in the FGDs indicated that the lack of funding for ICT was one of the barriers to successfully integrating ICT in their school. Participants revealed that schools need to purchase new ICT devices for educational purposes, connect the wireless network for the Internet and replace older ICT devices. These needs should be supported by sufficient funding. Two of the participants stated *(Quoted verbatim)*

“When we want to increase our ICT integration in schools, we need more devices such as computer, projector, and more importantly the Internet. Inter,” (P1)

“I would to state that there are plenty of older device in our schools that need to be replaced by the new ones. However, we have not enough budget to spend within this need.” (P27)

The second external barrier discussed in the FGDs was lack of professional development. More than 83% of the participants had the perception that there were significant barriers to integrating ICT in line with the lack of professional development for teachers to improve both their knowledge of ICT skill and ICT integration into teaching. One of the participants stated that although there had been good ICT devices available in the school for teaching and learning processes, there was insufficient training or workshops to support the ICT integration performance. Another participant indicated that many ICT-based professional development programmes did not have adequate follow-up training, workshops, or field practices on how to effectively use ICT for
instruction. P12 noted that many programmes offered by either public or private institutions did not support, not only teachers to extend the use of ICT during teaching and learning processes and the significant advantages using technology compared to traditional teaching styles, but also principals to manage the administration and do supervision in relation to ICT integration in education.

The third external barrier found in this study was school culture. Twenty-three participants perceived that the culture of schools could also be a significant barrier for ICT integration in their school. One participant reported that when teachers were told that there would be new ICT devices for instructional activities, they made comments such as, “We purchase ICT devices, then the irresponsible students damage them. It is so annoying that the situation might happen in our school”. In addition to broken devices caused by a few students, some school principals believed that school cultures including the way teachers in the classroom are ingrained, prevent or hinder ICT integration during teaching and learning processes. One of the participants noted,

“If the government want to make ICT integration become a success story. It needs to establish school culture that embraces the use of such technologies.” (P15)

Half of the participant (15 principals) with thirty-five responses mentioned that the district culture was also a barrier to technology integration in this study. Five participants shared in the discussions that the culture of district became one of the competitive challenges for limited ICT resources in their school. One of the participants, (P6) said that the head of the department in charge for operational stuff in his district was a barrier because he neither supported the ICT integration nor purchased ICT devices for the school in his district.

Internal barriers

The internal barriers revealed in this qualitative phase our were lack of teachers’ knowledge of ICT and its integration for active learning, lack of teachers’ understanding of ICT and its integration and traditional teaching styles (see Table 4). The first internal barrier identified was lack of teachers’ knowledge of ICT and its integration for active learning perceived by most participants in the FGDs. One participant (P10) reported that the barrier was related “how proficient the teachers understand technology in general and how good they integrate ICT into their classroom routines.” Another participant (P13) declared that this lack of knowledge of ICT and its integration was “the most important factor predicting the teachers’ decision to use or not to use ICT in their instructional activities.”

Lack of teachers’ understanding of ICT and ICT integration was another sub-theme revealed from the qualitative analysis. We identified this sub-theme from twenty-nine participants’ opinions in the FGDs. One of the participants (P7) revealed “Self-efficacy of the teachers is a significant barrier for ICT integration in my school. I have even talked to some of them and they informed me that they lack have lack confidence teaching with ICT.” Another principal (P2) also said that understanding for ICT integration was not the only barrier, but also understanding using the ICT devices as a barrier informed in this study.

Twenty-two participants indicated that the traditional teaching style was another barrier to ICT integration in the school they lead. Participants took the view that the uneasy shift from the teacher-centred teaching class to student-centred learning was a barrier. O ne participant (P28) said that teachers, especially senior teachers, have had many years of training and practices to conduct instructional activities in a specific way where students just listen to their lecture with no innovation in the teaching and learning processes.

6. Discussion

The preliminary findings of this study indicated that the most highly identified external barriers were mainly related to lack of funding such as inability to provide computers and the Internet in classrooms, no support to refresh programmes for older computers and other devices as well as insufficient technical supports to solve technological problems. This result is somewhat surprising because the Indonesian government has spent 20% of the national budget on educational funding including the cost of ICT implementation and its support (Sofwan and Habibi, 2016; Luschei, 2017). The results agree with some previous related studies in other developing countries (Kilinc, Tarman and Aydin, 2018), which maintained that teachers perceived a lack of funding to provide computers’ software and hardware as well as the internet as barriers for technology
integration. Another study by Wachira and Keengwe (2011) reported that Japanese schools found formidable barriers, specifically the absence of media specialists/technology technicians similar to this study result. Professional development regarding ICT integration for effective and efficient teaching and learning processes is an essential component to promote the use of ICT during instruction (Derbel, 2017). However, professional development programmes can be, in some circumstances condition, be perceived as one of the significant barriers for ICT integration when the programmes are not in relation to actual teaching practices or merely focused on ICT skill development (Tarman and Chigisheva 2017). This study also revealed similar results, the Indonesian school principals stated that the professional development courses that teachers need to attend were not relevant to their needs for integrating ICT. They perceived insufficient technology-related professional developments as one of the barriers. Briefly, the conclusion can be drawn that the perceived barriers of school principals to ICT integration in instructional activities show similarities across time, space, and culture.

From the survey and FGDs, it is revealed that the participants of this study believed that teachers’ lack of knowledge of ICT and its integration, lack of confidence in using ICT integration delete, and beliefs in traditional teaching styles were the external barriers for ICT integration. Teachers’ level of ICT skill and confidence were predicting factors and had a significant influence on the quantity of ICT integration used to support teaching and learning processes (Cui and Vowell, 2013; Alkhawaldeh and Menchaca, 2014). One of the significant findings revealed that the lack of necessary knowledge is an unavoidable barrier to ICT integration in education (Mackenzie 2013).

In addition to teachers’ lack of knowledge and confidence of ICT and its integration, traditional teaching styles were also revealed as a barrier that could not easily be overcome. This barrier is very complicated and has been rooted in school teaching cultures in relation to teachers’ background, education and experiences, and thus it is difficult to overcome (Tondeur, et al., 2009; Cuban and Jandric, 2015). Most principals that participated in the FGDs believed that the traditional teaching style was a lasting barrier for many teachers, particularly older teachers. This finding is in alignment with previous studies (Ertmer, et al., 2012; Kim, et al., 2013; Mueller, et al., 2008).

7. Implication
This study recommends that district-level educational authorities should provide and develop professional development training programmes for principals and teachers to improve effective ICT plans with an emphasis on ICT integration in schools. This training programme is crucial for principals to comprehend and evaluate the significance of collaborating to establish set specific goals regarding ICT integration, setting an appropriate budget plan for ICT purchases and updating old technological devices, and recognizing supports for teachers, as well as including balanced professional development opportunities. When principals are trained, they will be able to start the process of revision or development, and finalisation of a technology plan with real effectiveness for the school.

Principals should be committed to working in collaboration with schools’ staff members to develop a short and long term ICT integration plan. Early steps would be developing the current inventory of technologies, teachers’ needs, and annual objectives for a computer ratio for students. In addition, schools should move towards a programme of one device per student. They should plan to utilize and organize computer labs to support academic activities. This plan should include the proposal of funding sources and the potential funding capacity to purchase new technological devices, renew old and slow devices and support the maintenance of the wireless capacity within their school sites. The district’s technology departmental authorities should be invited to get involved, or at least to have a discussion and consultation when the plan is established and implemented.

References


A Learning Analytics Approach to the Evaluation of an Online Learning Package in a Hong Kong University

Dennis Foung and Julia Chen
English Language Centre, The Hong Kong Polytechnic University, Hong Kong, China
dennis.foung@polyu.edu.hk

Abstract: In recent years, research using learning analytics to predict learning outcomes has begun to increase. This emerging field of research advocates the use of readily-available data to inform teaching and learning. The current case study adopts a learning analytics approach to evaluate the online learning package of an academic English course in a university in Hong Kong. This study aims to (1) explore the completion pattern of use of the online learning package by students in a generic undergraduate academic skills course; and (2) predict student outcomes based on their online behaviour patterns. Over three academic years, the study examined usage logs for 7000+ students that were available on the university’s learning management system. Student assessment component scores, online activity completion rates, and online behavioural patterns were identified and examined using descriptive analysis, bivariate correlation analysis, and multiple regression analysis. The findings reveal insights into different online learning behavioural patterns that would benefit blended course designers. For instance, some students started using the online learning package early in the semester but fulfilled only the minimum required online work, whereas others greatly exceeded the basic requirement and continued doing activities in the online package even after the semester had finished. The relationship between learning activities in the online package and assessment component grades was found to be weak but meaningful. A regression model was developed drawing on the completion rates to predict overall student scores, and this model successfully identified several specific factors, such as total number of attempts and performance in individual online learning activities, as predictors of the final course grade.

Keywords: learning analytics, blended learning; online learning package, English for academic purposes, Hong Kong, course design

1. Introduction

When Hong Kong’s university curriculum changed in 2012 from a three-year structure (British system) to a four-year one (American system), the university in question seized the opportunity to introduce a substantial blended learning component to its new English subjects via a Learning Management System (LMS). The introduction of the LMS was primarily driven by two considerations. First, the new English courses were offered in the form of one 3-hour session per week (instead of one 2-hour session and one 1-hour session), a change that gave students considerable time to study and complete their work before their next class. Second, since blended learning approaches around the globe have proven successful, the university’s course designers built on studies that identified the benefits of blended learning for students in a higher education context over the last decade (e.g. Fischer, 2007; Huon, et al., 2007), in order to include a blended learning component in their new English for Academic Purposes (EAP) courses.

When the first four-year curriculum cohort was in their final year of study, it was felt that a more comprehensive curriculum review was warranted. Despite receiving excellent feedback from stakeholders such as students, teachers, and external reviewers through the institution’s quality assurance mechanism, students’ online behaviour and the nature of their engagement with online learning components remains under-explored. Therefore, the current study set out to examine students’ behaviour with regard to the online learning package more closely, in order to inform future blended learning designs for the EAP context. For more details of the full curriculum review, see Chen (2018) and Chen, Foung and Armatas (2018).

This study adopts a data-driven approach to understand the behaviours of students completing blended learning activities and to explore the impact of blended learning tasks to course assessment. This study is highly relevant and important to the field of Computer-Assisted Language Learning and EAP because (1) understanding the behaviors of students facilitates more effective development of blended learning activities; and (2) establishing the relationship between blended tasks and course performance can help evaluate the effectiveness of blended task in an evidence-based manner.

The next section presents a literature review on the establishment of learning analytics as a research interest in Computer-Assisted Language Learning (CALL) and how it facilitates CALL design. This is followed by a methodology section that introduces the course, participants, CALL activities, and data analysis procedures adopted in the current learning analytics study. The findings are then presented and discussed, including the general pattern of completion, the ‘cut-off’ effect, the acquisition of writing skills, and a predictive model for overall grades. The article concludes with a number of suggestions for blended learning teachers and researchers.

2. Literature Review

The use of learning analytics in the field of Computer-Assisted Language Learning (CALL) can contribute to developing an understanding of students and their behaviours in completing blended learning tasks. Various previous studies drawing on learning analytics have successfully explained how students’ self-regulating behaviours affect their performances and engagement in blended learning activities (e.g. Fischer, 2007; Zacharis, 2015; Zheng, et al., 2016). Students who can self-regulate and attain goals engage best in a blended environment (Arispe and Blake, 2012). In addition to this principle, several other aspects have proven to be important areas in blended learning research, including student behaviours in an online environment, effective learning design, and the association between blended tasks and their outcomes.

In recent decades, research has attempted to understand the online behaviours of students in various blended learning contexts. Unsurprisingly, students tend to be rather pragmatic when approaching blended learning; that is, they acquire knowledge to obtain good marks, instead of aiming to broaden their knowledge (Huon, et al., 2007). Some CALL learners could even be described as adopting a ‘principle of minimal effort’ approach (Fischer, 2007, p.419). This aligns with the findings of previous empirical studies (e.g. Li, 2014) that students complete necessary online learning tasks without doing more than the minimum required for learning. Despite this, blended learning designs are still being promoted, since diversity in a carefully-planned course delivery approach can create better learning experiences (Kahn, et al., 2017). For example, the diversity and interaction between delivery modes in blended learning is likely to improve students’ satisfaction with the course (Naveh, Tubin and Pliskin, 2010; Zacharis, 2010). Teacher presence seems to be particularly effective in enhancing the effectiveness of online material delivery (Hegeman, 2015). In Hegeman’s study, teacher presence refers to the adoption of teacher-prepared notes, instead of consulting external websites for help or clarification. This is echoed in a recent review by Nortvig, Petersen, and Balle (2018) that states that educator presence is a dominating factor influencing e-learning and learning outcomes. Another key influencing factor is the deliberate connections designed into the learning activities of the online and offline parts of a course. Online and offline activities should be integrated so that learning can expand from the classroom to out-of-class learning, and vice versa.

Blended learning research has also focused on identifying effective blended learning designs and understanding learner preferences, and these aspects provide further insights into blended learning in a language-learning context. Generally speaking, students are becoming more comfortable with online learning via a Learning Management System, and feel that such online learning can help improve their course performance (Uziak, et al., 2018). According to Arispe and Blake (2012, p.459), students with poor spoken language proficiency tend to prefer traditional blended learning materials (i.e. one-way delivery/without the presence of an instructor) which allow them to learn at their own pace without being ‘overwhelmed’ by an instructor. They believe that students with poor spoken language proficiency can enjoy their learning in the online component of a blended learning course, as there is no instructor asking them to respond to questions spontaneously. Li (2014) also suggests that when given the opportunity to choose how they want to fulfil their blended learning requirement, some students prefer to do web exercises, while others prefer to interact with peers via online group discussions. Zhu, Au, and Yates (2016) believe that text-heavy online tasks (such as keeping an online journal or responding to a discussion thread) can help activate certain self-regulated learning behaviours, such as planning and reflection, and thus these exercises play a significant role in blended learning. Heift (2003) examined the impact of different types of web task on student learning. She believes that some exercises allow for more freedom (e.g. drag-and-drop and gap-filling activities), while others provide a lower degree of freedom (e.g. multiple-choice questions). Here, freedom refers to the fact that students do more than simply click the correct answer (as in MC questions), but move the mouse to answer a question online (as in drag-and-drop exercises). Activities that allow for more freedom were found to have a more significant impact on students’ learning. These studies suggest that the types of activity that are made
available (e.g. discussion, multiple-choice questions, drag-and-drop, or gap-filling) can affect students’ learning. Hershkovitz and Nachmias (2011) believe that further research is needed in this domain to extend our understanding of students’ online behaviours in blended teaching and learning contexts.

In addition to students’ online behaviours, predicting students’ learning outcomes appears to be important within the blended learning research paradigm, with learning outcome used as a common way to define the effectiveness of e-learning (Noesgaard and Ørngreen, 2015). Skeptics have argued that the relationship between delivery mode and student outcomes is generally rather weak (Dziuban and Moskal, 2011; Moskal, Dziuban and Hartman, 2013); however, other academics have continued to explore such relationships by including different factors in their predictive models. Several studies have concluded that participatory variables, such as course login frequency, reading course announcements, and accessing course materials, are significant predictors of final course grades (Chen, 2013; Chen and Jing, 2010; Damianov, et al., 2009; Dawson, McWilliam and Tan, 2008; Tempelaar, Rienties, and Giesbers, 2015; Zacharis, 2015; Zhu, Au and Yates, 2016). Macfadyen and Dawson (2010) identified some influential participatory variables, such as total number of discussion messages posted, total number of mail messages sent, and total number of assessments completed. Some studies have also evaluated the predictive power of other factors; for example, one study found that students’ motivation predicts their performance (Zhu, Au and Yates, 2016), while another study concluded that other demographic factors, such as university entrance exam marks, can be good predictors of students’ performance and final scores in a blended learning course (López-Pérez, Pérez-López and Rodríguez-Arizá, 2011).

Other than these e-learning-based studies, it is important to take note of some learning analytics studies using advanced data mining techniques, such as Asif, Merceron, Ali, and Haider (2017) and Foung (2019). They also attempted to explore ways to predict students’ performance and have not yet included blended learning variables. The data mining methods such as classification trees and logistics regression analysis can be applied to blended learning studies to predict students’ performance and this was echoed by Rodrigues, Zárate, and Isotani (2018).

However, little research has been conducted to explore how blended learning components can predict final course grades. Only a few studies have confirmed that online activities performance can predict students’ final results (e.g. Macfadyen and Dawson, 2010; Tempelaar, Rienties and Giesbers, 2014). Hence, there is room for further investigation in this respect.

Despite past efforts to understand students’ online behaviours and the role of blended learning in the development of academic writing skills, there is still room for a learning analytics approach to assess these and to explore the predictors of learning outcomes in blended academic skills courses. To be precise, this study aims to answer the following questions:

1. How many online activities did students complete?
2. How much time did students spend on online activities?
3. Is the ‘pragmatic’ approach to online activities applicable to the current context? If so, how?
4. Can students’ behavioural patterns in blended learning components predict their academic outcomes?

3. Methodology

The following sections describe how the research was conducted with the readily-available data on the LMS and detail how the course and its online activities were designed.

3.1 Participants

This study adopted a convenience sampling approach and retrieved the learning data of students taking a university English course, English for University Studies (EUS) from the university LMS between 2012/13 and 2014/15. In other words, entries were retrieved as long as they were available and no probabilistic computation was involved in acquiring the data. The learning data of 7,156 students were eventually retrieved for analysis, most of which comprised the access log data available on the LMS, such as which learning activities students had selected, when students had commenced working on the learning activities, and what scores they had received for each activity.
3.2 Ethical Clearance

The Ethical Review for Teaching/Research involving human subjects of this project was approved by the Departmental Research Committee and recorded on the university Human Subjects Ethics Application Review System (Reference Number: HSEARS20160812002).

3.3 Course and Assessments

EUS is a foundation EAP course taken by two groups of students at different English proficiency levels. Most students attain a Level 4 in English in the Hong Kong secondary school exit examination (equivalent to an IELTS [International English Language Testing System] score of 6.30–6.51) while the remaining students attain Level 3 in the same exam (equivalent to an IELTS score of 5.48–5.56). Students who attain a Level 3 must first take a proficiency-based English course, followed by EUS, the foundation EAP course. Meanwhile, Level 4 students take EUS as their first English course in university. In the data set selected for the current study, 33.6% of students took this course as their second English course (Level 3), while 66.4% took this as their first English course (Level 4).

The aim of EUS is to...

In order to pass the course, students taking EUS must complete three assessments and independent online learning task (IndiWork) requirements. The first assessment comprises an in-class writing assignment focusing on a problem-solution essay, while the second one comprises a take-home expository essay. Finally, the third assessment comprises an in-class pair work presentation. These three assessments contribute to the final course grade. In addition, students must fulfill an 80% attendance requirement and an e-learning requirement, which is the focus of this study, called IndiWork. The minimum score for IndiWork in 2012/2013 was 60%, and that for 2013/14 and 2014/15 was 50%. Failure to meet any of these requirements will lead to an overall grade reduction, but completing more than the minimum will not lead to an improvement in the overall grade.

3.4 IndiWork

The aim and design of IndiWork is to provide students with extended and out-of-class learning opportunities related to the subject’s learning outcomes. Hence, the content of IndiWork is directly relevant to the course content, that is, academic writing and academic speaking. All activities were developed by course designers with experience in teaching generic academic skills and were reviewed by the subject leader of the course. Each IndiWork activity comprises an individual web exercise with several questions posted on the university LMS; most activities adopt a gap fill, mix and match, and/or multiple-choice format. Some activities may ask students to watch a tailor-made video posted on YouTube before completing the exercise and some provide textual pre-task input for students. As an example, a list of blended learning activities in 2014/15 is presented in Appendix One. Students were offered a total of 15 learning activities in 2012/13 and 18 activities in 2013/14 and 2015/16. Although there were minor changes to the activities across cohorts in the years studied, the activities remain comparable in terms of content and level of difficulty. Most IndiWork activities are relevant to the EAP course, such as ‘paragraph cohesion’ and ‘paraphrasing and summarising’, while the remaining activities relate to general proficiency, such as vocabulary building. Depending on the course schedule, some IndiWork tasks are made available at the beginning of the term and expire in the middle of the term. For example, academic style is taught as the first unit of the course, so IndiWork activities on academic style start at the beginning of the term and expire in the middle of the term. Due to the teaching schedule, most other tasks are made available later in the term and expire at the end of the term. The course designers hope that this approach will motivate students to complete a class-related exercise soon after/before they have learned the corresponding skill in class.

Among the IndiWork activities that are available, students can choose which they want to complete to fulfil the minimum requirement. All activities are automatically and immediately marked by the system, and students know their total score for the activity and which items they have completed correctly. The total score
of each individual IndiWork activity will count towards the overall IndiWork score. Students have unlimited attempts to do any activity, but only the score of the final attempt counts towards the IndiWork total score.

### 3.5 Data collection and procedures

Assessment results and IndiWork records are stored on the LMS; a list of variables is presented in Table 1. All teachers make use of this system to enter four component grades for each assessment for each student, and the system derives a final grade based on the component grades that are entered. The overall grade used for this study is calculated based on the overall assessment grades of the three assessments. The component grades for the written assessments are Content, Organization, Language, and Referencing, whereas those for spoken assessments are Content, Delivery, Language, and Pronunciation and Fluency. The University common assessment scheme specifies that students be assigned one of nine possible ordinal scores: 4.5, 4.0, 3.5, 3.0, 2.5, 2.0, 1.5, 1.0, 0, with 4.5 denoting ‘Outstanding’, 3.0 ‘Good’, C ‘Satisfactory’, 1.0 ‘ Barely Adequate’, and 0 ‘Inadequate’.

Students’ IndiWork records are available on the LMS for students to see. The IndiWork total score is the most important indicator, ranging from 0 to 1 (i.e. 0% to 100%), due to its direct implications for the overall grade (for details, see section 3.3 on Course and Assessments), and has been converted to a decimal number. To facilitate the analysis in this study, students were divided into seven groups according to their IndiWork scores: Group 1 for students from 0–0.25 completion; Group 2 (0.25–0.4999); Group 3 (0.5–0.5999); Group 4 (0.6–0.6999); Group 5 (0.7–0.7999); Group 6 (0.8–0.8999); and Group 7 (0.9–1). On top of the total scores, the date and time of completing the IndiWork tasks were recorded by the system. The day that a student started an IndiWork task and the day on which a student finished his/her latest IndiWork task were also computed. In addition, for analysis purposes, the number of days between the first and last days was computed. In terms of total attempts were retrieved. Since each IndiWork activity corresponded to one or more assessment components (i.e. each IndiWork activity was designed to help students with at least one of the assessment components), the sum of all relevant IndiWork scores for a particular component was computed for analysis.

| Table 1: List of Variables Retrieved from the Learning Management System (LMS) |
|---------------------------------|------------------|
| Groups of Variables              | Range            |
| Level of English Public Exam     | 3–4              |
| Overall Course Grade            | 0–4.5            |
| IndiWork Total Score            | 0–1.0            |
| Individual Component Scores of IndiWork | 0–1.0        |

### 3.6 Data Analysis

After the data were retrieved, some entries were removed to maintain a valid data set. The records of students who, for various reasons, could not complete the course were removed. Next, a round of exploratory and descriptive analysis was conducted, including bivariate correlation analysis and descriptive statistics for various variables. After the exploratory stage, rounds of data testing and screening were carried out. Normality tests were performed with all relevant variables by visually inspecting the histogram. After the data cleaning procedures, several inferential statistical analyses, including bivariate correlation analysis and multiple regression, were conducted using IBM SPSS 23.

Because some parts of the dataset were not directly comparable, descriptive analysis was conducted for each individual student cohort. To allow generalizability, scores in activities were grouped under common categories, such as ‘Unit 2 Activity on General Referencing’. Because the mean scores of each activity were used, such categories may represent the mean scores of two activities in 2012/13 or three activities in 2013/14. This use of mean scores made comparison across cohorts possible.

To conduct the multiple regression analysis, several assumptions needed to be met; thus, a number of steps were taken to ensure the validity of the analysis. First, the tolerance of included variables was checked to see if it was greater than 0.1. No variables presented violated this threshold. Unusual points were also detected and removed. The unusual points were standardized residual (> |3|) and Cook’s distance (> 1) (Cook and Weisberg, 1982). Ultimately, 35 entries were deleted due to unusual standardized residuals. Next, the normality of the
residuals was verified by visually inspecting the histograms and residuals in both models and confirming whether both were normally distributed. Finally, the analysis was run for a second time and the findings are presented and discussed in the next section.

4. Results and Discussion

The following sections examine how students completed the online activities designed for them, how these tasks facilitate acquisition of academic writing skills, and whether students’ academic outcomes can be predicted with the variables related to blended learning components.

4.1 An Overview of IndiWork Completion

i. Completion Rate

Generally speaking, a high proportion of students completed the IndiWork activities. Tables 2a and 2b show the completion rates of IndiWork in different cohorts. The mean completion rate was 74.32% (2012/13; required minimum = 60%) and 62.06% (2013/14 and 2014/15; required minimum = 50%); in total, 94.7% of students completed the requirement (≥ 60%) in 2012/13 and 95.2% (≥ 50%) in 2013/14 and 2014/15. Among those students who met the requirements, a significant number (32.4% in 12/13; 26.2% in 13/14 and 14/15) did 10% more than the minimum required (Tables 2a and 2b).

| Table 2a: IndiWork Total Score 2012/13 (n = 2,241; minimum required: 60%) |
|-----------------|-----------------|
| Percent    | Cumulative Percent |
| 0 – 24.99%   | .2               |
| 25% – 49.99% | 1.1              |
| 50% – 59.99% | 2.6              |
| 60% – 69.99% | 35.9             |
| 70% – 79.99% | 27.8             |
| 80% – 89.99% | 20.3             |
| 90% – 100%   | 12.1             |
| Total        | 100.0            |

Mean = 74.32%

| Table 2b: IndiWork Total Scores 2013/14 & 2014/15 (n = 4,915; minimum required: 50%) |
|-----------------|-----------------|-----------------|
| Percent    | Cumulative Percent |
| 0 – 24.99%   | .5               |
| 25% – 49.99% | 3.7              |
| 50% – 59.99% | 52.1             |
| 60% – 69.99% | 17.6             |
| 70% – 79.99% | 12.6             |
| 80% – 89.99% | 9.1              |
| 90% – 100%   | 4.4              |
| Total        | 100.0            |

Mean = 62.06%

The high completion rate across all three cohorts of students (2012/13 to 2014/15) shows that students were mindful of the course’s e-learning completion requirement. Although meeting the minimum requirement does not lead to a higher course grade, failure to complete IndiWork results in a reduction of the course grade. This seems to provide a sufficiently strong incentive for students to engage with e-learning. A more in-depth
analysis of completion rates and their effect will be discussed in section 4.1.3 on ‘Cut-off Effect’ following the presentation of some other e-learning parameters below.

ii. Time Spent on IndiWork

While a last-minute rush would make the IndiWork less relevant to student learning, the analysis showed that, in fact, most students did not complete their IndiWork within the last few weeks of the semester, but spread it over an average timespan of eight weeks. On average, students took approximately eight weeks to complete IndiWork between the first and last days of the semester (8.96 weeks for 2012/13; 7.31 weeks for 2013–2015; Table 3). With the EUS course lasting for 13 weeks in 2013/14 and 2014/15, the seven-week time interval recorded in these years seems sensible, in that students spent half the semester engaged in e-learning tasks. In 2012/13, students began earlier (in the first 1.5 weeks) and worked for approximately nine (i.e. 8.96) weeks, as they had to complete a minimum of 60% of tasks in a maximum of 14 weeks. However, students enrolled in 2013/14 started later (in the second week), and spent just 7.31 weeks on their IndiWork to complete an average of 50% of tasks, despite having 13 weeks to work on them. It is also interesting to note that the maximum duration was 104 days, which means that some students (n=60; 0.8% of the total student sample) continued working on the online tasks even after the course had ended. The reasons for these phenomena will be explored in the next paragraph.

Table 3: Key Indicators of IndiWork Activities

<table>
<thead>
<tr>
<th></th>
<th>Minimum 2012/13</th>
<th>Maximum 2012/13</th>
<th>Mean 2012/13</th>
<th>Std. Deviation 2012/13</th>
</tr>
</thead>
<tbody>
<tr>
<td>IndiWork Total Score</td>
<td>0.0286</td>
<td>0.00</td>
<td>1.00</td>
<td>0.7432</td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td>1.00</td>
<td>0.620%</td>
<td></td>
</tr>
<tr>
<td>Total No. Attempts</td>
<td>1</td>
<td>1</td>
<td>21</td>
<td>11.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>28</td>
<td>13.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.764</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.880</td>
</tr>
<tr>
<td>Duration of IndiWork</td>
<td>0</td>
<td>0</td>
<td>98</td>
<td>62.69</td>
</tr>
<tr>
<td></td>
<td>-3</td>
<td>-3</td>
<td>96</td>
<td>51.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17.429</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22.444</td>
</tr>
<tr>
<td>Starting day (X days after the term starts)</td>
<td>-3</td>
<td>-3</td>
<td>82</td>
<td>10.62</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>89</td>
<td>15.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10.472</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15.156</td>
</tr>
<tr>
<td>Ending day (X days before the term ends)</td>
<td>-9</td>
<td>1</td>
<td>101</td>
<td>19.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>104</td>
<td>28.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16.115</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20.181</td>
</tr>
</tbody>
</table>

The results show that in a 13/14-week semester, students spread their IndiWork over eight weeks on average. This seems to suggest that students did not cram in the IndiWork just before the completion deadline at the end of the semester. In contrast, the average end day for IndiWork was in Week 10, which means that many students did less IndiWork in the final three weeks of the term. There are two possible explanations for this: that most students had already completed more than the minimum by Week 10, or that students were too busy with other assignments and courses at the end of the semester to focus on IndiWork. The cut-off effect addressed in the next section will provide more insights into this. Not all students, however, stopped in Week 10. As noted above, 0.8% of students (n=60) continued with IndiWork beyond the end of the semester, after their course grades had already been determined. This may reflect students’ perception of the usefulness of the online learning part of the course. It is possible that this small percentage of students did not have time to complete all the tasks prior to the end of the semester as they were busy with other assignments. Thus, they may have wanted to resume their learning process during the semester breaks. Such strategic planning skills call to mind the ‘self-control and self-regulation’ described in Zhu, Au, and Yates (2016). It is also possible that students were not clear about certain concepts in academic writing while completing their coursework for core courses (e.g. how to format in-text citations for multiple citations). They then sought answers in these activities.

iii. Cut-off Effect

As students had the freedom to choose the activity type and sequence and when to do the activities, this section examines when students stopped doing online activities, to establish if there was any cut-off effect. Table 4 presents the completion details of IndiWork across cohorts. All activities are listed in the order they were presented to students, together with the mean score for each activity (note: scores have been rescaled
between 0 and 1) and the corresponding cumulative IndiWork percentage. The second to last column, the attempt rate, refers to the percentage of students who attempted each activity. It should be emphasized that attempt rate here refers to the number of students rather than the number of attempts (which can be more than one per student). The last column simply provides the difference between the attempt rate of the activity shown on that row and that of the previous activity. For example, the mean scores in 2013/14 for the Pre-Unit 1 activity and Unit 1 activity were 0.93 and 0.95, respectively. If a student attained the mean scores in both activities, they would be awarded 0.0609 in total for their IndiWork. If a student managed to obtain the mean scores for each activity, by the time they had completed the Unit 3 activity on ‘discursive essays/for and against essays’, they would have attained 0.5502; that is, the minimum completion requirement for IndiWork for that year. The noteworthy point is that the attempt rate always showed the largest drop once the cumulative percentage had reached the minimum requirement; that is, 60% in 2012/13 and 50% in 2013/14 and 2014/15 (underlined in Table 4). Such a drop indicates that a certain number of students stopped doing IndiWork after attaining the minimum and this echoes the discussion above. The ongoing decrease in the attempt rate confirms that students stopped doing the activities rather than skipping particular activities. This suggests that there was a cut-off effect, as a clear majority of students stopped doing IndiWork once they had reached the minimum requirement.

Table 4: Completion Details of IndiWork across Cohorts

<table>
<thead>
<tr>
<th>Activity</th>
<th>Mean</th>
<th>Cumulative IndiWork % Attained</th>
<th>Attempt Rate</th>
<th>Change in Attempt Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Unit 1 Activities: IndiWork and CILL Quiz, updating your profile</td>
<td>0.93</td>
<td>2.15%</td>
<td>86.0%</td>
<td>---</td>
</tr>
<tr>
<td>Unit 1 academic style</td>
<td>0.88</td>
<td>9.44%</td>
<td>97.3%</td>
<td>+11.3%</td>
</tr>
<tr>
<td>Unit 1 precise words and hedging</td>
<td>0.89</td>
<td>13.19%</td>
<td>92.6%</td>
<td>-4.7%</td>
</tr>
<tr>
<td>Unit 2 what and why of referencing</td>
<td>0.9</td>
<td>20.15%</td>
<td>96.5%</td>
<td>+3.9%</td>
</tr>
<tr>
<td>Unit 2 referencing styles</td>
<td>0.9</td>
<td>24.07%</td>
<td>91.2%</td>
<td>-5.3%</td>
</tr>
<tr>
<td>Unit 2 in-text referencing</td>
<td>0.9</td>
<td>27.98%</td>
<td>82.9%</td>
<td>-8.2%</td>
</tr>
<tr>
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Unfortunately, this cut-off effect is not unusual in blended learning, CALL, or in learning science in general. The authors believe that this reflects the ‘principle of minimal effort’ suggested by Fischer (2007, p.419) and, similarly, the pragmatic approach suggested by other academics (Huon, et al., 2007). The only difference here is that, instead of seeking to obtain good marks, these students strove to meet the minimum requirement to avoid a penalty, as reported in previous studies. Worse still, under the current course design, students do not obtain extra marks in assessments for doing more, so they simply stop once they have met the requirement. A reason for concern might be that these students did not seem to consider whether they were stopping at an appropriate place in the series of online activities (i.e. making an informed decision to stop the learning process based on the course outline). These students simply stopped whenever they had reached the minimum (e.g. a language/referencing exercise in 2012/13, a content exercise in 2013/14, and an organization exercise in 2014/15). They therefore missed some essential concepts that course designers intended to introduce through these blended learning exercises. For example, most presentation-related IndiWork tasks had a low number of attempts across cohorts as they were post cut-off. Demonstrations of how to handle questions in a presentation (Unit 4, Activity 3: see https://youtu.be/y0dvug5rID8) were thus neglected, and this has implications for the learning progress of students in completing their presentation assessment (Assessment 3). The findings here suggest that CALL designers should consider sequencing activities according to their importance instead of according to the learning sequence; this would ensure that all important activities are completed before the cut-off point. In other words, the course designers would have to estimate the cut-off point (e.g. Activity 5) and include essential activities prior to that point (thus requiring students to complete the essential activities) to increase the chance of students completing all or most of the essential activities.

In the light of the existence of a noticeable cut-off effect, when teachers design online curricula and activities, they should bear in mind the tendency of students to adopt the principle of minimal effort. In this case, the cut-off effect appears to be only related to students’ perception of the availability of tasks. In fact, when applying the principle of minimal effort, students could have other considerations, such as the level of difficulty of a particular task, or the relevance of online tasks to assessments. Any of these factors can help students decide which online tasks to complete, and controlling these factors (e.g. availability of tasks) would allow teachers to manipulate the student online behaviours. The authors suggest that course designers consider the following: 1) setting a release date and end date for each online task that align with the classroom learning schedule, i.e., controlling the availability of tasks; 2) ranking tasks according to their level of relevance to assessments, i.e. showing the perceived impact of completing the tasks; (3) adopting an adaptive release mechanism whereby the next tasks are not released until the current tasks have been completed satisfactorily, i.e. controlling the availability and the order of tasks; (4) setting some tasks as compulsory and giving more weighting to these tasks, i.e. giving incentives to students to complete the online package at faster pace. Course designers can adopt these measures to influence students’ online learning behaviour so that students attempt activities related to all the main learning outcomes before arriving at the cut-off point.

4.2 Predicting student outcome

To predict the overall course grade, eight independent variables were entered into the regression model. These variables were chosen because of their theoretical requirement (such as demographic factors and public exam scores as an indicator of language foundation) and the empirical correlation (scores of the first few IndiWork tasks). The adjusted $R^2$ of the model is 0.116 and $R^2$ is 0.1312 (small). This shows that the model can only predict a small portion of deviation of the overall course grade (Table 6a). Because the eight independent variables are significant predictors of overall course grade, it is worthwhile presenting these variables in a detailed manner. The total number of attempts at IndiWork can best predict the overall course grade (standardized $\beta = 0.139$, $p < 0.05$), followed by scores for IndiWork Unit 1 activities (standardized $\beta = 0.136$, $p < 0.05$), start day (standardized $\beta = -0.078$, $p < 0.05$), and scores for IndiWork Unit 2 general referencing activities (Table 6c). These four most influential elements are IndiWork-related factors, rather than demographic factors like public exam results. Apart from the strength of the regression coefficients, it is also interesting to note the net effect of certain variables on the predicted value of the regression equation. For every one-unit change (i.e. one attempt) in ‘total number of attempts’, there is a change of approximately 0.022 points to the overall course grade if the values of other independent variables are held constant. If students attempt activities (as an example) another 23 times, the overall course grade is predicted to increase by half a grade (e.g. C to C+).
The predictive power of blended learning activities on student outcomes was rather weak. The weak predictive power of the regression equation estimated in this study can be explained by the fact that only one, among many, of the academic skills can be noticeably enhanced through the blended learning environment (i.e. referencing skills), while other language skills need more practice to see obvious improvement, as discussed in the previous section.

Despite its focus on participatory variables (see Damianov, et al., 2009; Dawson, McWilliam and Tan, 2008), the previous literature has mainly focused on other effort-based participatory variables, such as course login frequency, reading course announcements, and access to course materials, but not the performance-based participatory variables in this study, such as scores in IndiWork. Perhaps future research can be conducted to explore the relationship between blended learning task performance (as performance-based participatory variables) and achievement of course outcomes.

The prediction equation established in this study can be useful for learning and teaching purposes. In particular, most predictors identified in this study can be obtained by the midterm, that is, with the scores of the first few IndiWork activities. This will allow student course performance to be predicted in the middle of the term, at-risk students to be identified early, and timely support to be provided to those students based on the course objective indicators. This corroborates previous studies, such as those by Klüsener and Fortenbacher (2015) and Essa and Ayad (2012), which discussed the benefits of learning analytics in identifying at-risk students.

4.2.1 Limitations

Although the researchers made every effort to ensure the quality of this study, there remain a number of limitations. First, although numerous studies have solely employed quantitative methods (e.g. Li, 2014), and although this learning analytics study can successfully identify certain trends and patterns such as the cut-off
effect, which is the model for predicting students’ outcome, more evidence from other data sources, for instance, using qualitative methods, could have been added to explain the patterns identified by this study. Second, as it was retrieved directly from the LMS database, the dataset for the current study was huge and it was not possible to thoroughly examine the problematic entries that were cleaned; it is also possible that some false negative entries were cleaned. In addition to the above methodological limitations, it is important to note that the cohorts and IndiWork tasks were not entirely comparable, because the course leaders made minor revisions to the content every year to improve the course. Furthermore, the whole blended learning design is the result of a major current reform in Hong Kong, and included a number of uncertainties and uncontrollable factors, e.g. the teacher’s perception towards blended learning. Nevertheless, this study employed sufficient quality assurance measures and checking mechanisms to minimize these impacts.

5. Conclusion

This study aimed to explore students’ online behaviours in the use of an online learning package and predict their outcomes with variables related to the package. The results indicate that students’ pragmatic approach to the completion of online tasks can be manipulated by a more thorough consideration of student behaviour when designing online tasks, including their available dates, priorities, and restrictions in task selection. In this way, the cut-off point can be pre-determined by teachers to better achieve learning outcomes. Unfortunately, students’ overall course grades were not well predicted by the online-activities-related variables, although the findings confirmed that a few performance-based blended learning indicators played a limited role in affecting the course grade. Future studies could attempt to combine blended tasks and other relevant external variables (e.g. demographic information) to establish a better model for blended learning courses, and consequently provide early indicators to enhance students’ academic English skills. More structured tasks that focus on language can be inserted before the cut-off point to encourage a higher attempt rate and to allow the impact of such activities to be properly measured for course improvement.

References

Dziuban, C. and Moskal, P., 2011. A course is a course is a course: factor invariance in student evaluation of online, blended and face-to-face learning environments. The Internet and Higher Education, 14, pp.236-241.
Foung, D., in press. Redesigning prediction algorithms for at-risk students in higher education: The opportunities and challenges of using classification techniques in a university academic writing course. In: Redesigning higher education initiatives for Industry 4.0. IGI Global.


### Appendix One. List of Activities for 2014-15 (Semester 2)

<table>
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<tr>
<th>Units</th>
<th>Components (No. of questions)</th>
<th>Example (with details) of a component</th>
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<tr>
<td><strong>Pre-Unit 1</strong>&lt;br&gt;Deadline: 23:55 Tuesday 3 February, 2015</td>
<td>Pre-Unit 1 Activities: IndiWork and CILL Quiz, updating your profile (17 points)</td>
<td>MC questions</td>
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<td><strong>Unit 1</strong>&lt;br&gt;Deadline: 23:55 Tuesday 3 March, 2015</td>
<td>Unit 1 IndiWork 1: academic style (30 points)&lt;br&gt;Unit 1 IndiWork 2: precise words and hedging (31 points)</td>
<td>Example of Unit 1 IndiWork 1: academic style&lt;br&gt;Video Input: <a href="https://www.youtube.com/watch?v=vfQjFXR5kk">https://www.youtube.com/watch?v=vfQjFXR5kk</a>&lt;br&gt;Exercise&lt;br&gt;Drag and Drop activity, on definitions of academic style issues (e.g. contraction)&lt;br&gt;Labelling activity, identifying style problems of a paragraph&lt;br&gt;Drag and Drop activity, on alternatives (i.e. fixing the academic style problems)</td>
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<td><strong>Unit 2</strong>&lt;br&gt;Deadline: 23:55 Tuesday 3 March, 2015</td>
<td>Unit 2 IndiWork 1: what and why of referencing (25 points)&lt;br&gt;Unit 2 IndiWork 2: plagiarism and information literacy (32 points)&lt;br&gt;Unit 2 IndiWork 3: referencing styles (52 points)&lt;br&gt;Unit 2 IndiWork 4: in-text referencing (32 points)&lt;br&gt;Unit 2 IndiWork 5: paraphrasing and summarising (30 points)</td>
<td>Example of Unit 2 IndiWork 1&lt;br&gt;Video Input 1: <a href="https://www.youtube.com/watch?v=GOv1xz7ddGY">https://www.youtube.com/watch?v=GOv1xz7ddGY</a>&lt;br&gt;Video Input 2: <a href="https://www.youtube.com/watch?v=46Tvl6fHODY">https://www.youtube.com/watch?v=46Tvl6fHODY</a>&lt;br&gt;MC questions on content presented in the videos</td>
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<td><strong>Unit 3</strong>&lt;br&gt;Deadline: 23:55 Tuesday 31 March, 2015</td>
<td>Unit 3 IndiWork 1: writing problem-solution essays (41 points)&lt;br&gt;Unit 3 IndiWork 2: essay introductions and paragraphs from sources (20 points)&lt;br&gt;Unit 3 IndiWork 3: cause and effect verbs and conclusions (30 points)&lt;br&gt;Unit 3 IndiWork 4: paragraph coherence (45 points)&lt;br&gt;Unit 3 IndiWork 5: for and against essays (34 points)&lt;br&gt;Unit 3 IndiWork 6: revising your work (42 points)</td>
<td>Example of Unit 3 IndiWork 1&lt;br&gt;Video Input <a href="https://www.youtube.com/watch?v=ezNC-EdIFt0">https://www.youtube.com/watch?v=ezNC-EdIFt0</a>&lt;br&gt;MC questions, on facts presented in videos, problems with Introduction paragraph, flow of an Introduction paragraph</td>
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<td><strong>Unit 4</strong>&lt;br&gt;Deadline: 23:55 Saturday 18 April, 2015</td>
<td>Unit 4 IndiWork 1: presentations - introductions and creating interest (22 points)&lt;br&gt;Unit 4 IndiWork 2: presentations - referencing, handover and conclusions (36 points)&lt;br&gt;Unit 4 IndiWork 3: presentations - Q and A and visual aids (19 points)&lt;br&gt;Unit 4 IndiWork 4: effective presentation delivery and body language (27 points)</td>
<td>Example of Unit 4 IndiWork 1&lt;br&gt;Video Input 1 <a href="https://www.youtube.com/watch?v=Ze3IiHsHuIA">https://www.youtube.com/watch?v=Ze3IiHsHuIA</a>&lt;br&gt;MC questions / Drag and Drop activity, on contents presented in videos&lt;br&gt;Video Input 2 <a href="https://www.youtube.com/watch?v=8ZTrc6C4mrsg">https://www.youtube.com/watch?v=8ZTrc6C4mrsg</a>&lt;br&gt;Labelling activity, on how to create interest</td>
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Language Proficiency and Smartphone-aided Second Language Learning: A look at English, German, Swahili, Hausa and Zulu

Eva Maria Luef¹, Bethel Ghebru² and Lynn Ilon³
¹College of Education, Department of German Education, Seoul National University, Seoul, Republic of Korea
²Institute of African Studies, Hankuk University of Foreign Studies, Seoul, Republic of Korea
³College of Education, Department of Education, Seoul National University, Seoul, Republic of Korea
bethelg@gmail.com

Abstract: Use and development of applications for smartphones (so-called ‘apps’) continue to rise, and it comes as no surprise that language learning apps (such as Google Translate) are immensely popular among the younger generation. But, do these apps actually help students learn a language and, if so, how is apps usage influenced by the proficiency of the language learner? Our research focused on the use of apps related to language learning in two major Korean universities. Koreans are known to be high-tech users and avid language learners, and Korea can therefore provide a good model for how education and technology intersect. We asked students studying German, Swahili, Hausa, and Zulu to inform us about the role that smartphone apps play in their language learning, both at home and in a formal education setting (e.g., classroom). Results showed that one important determinant for how apps were used was language proficiency. We further found an interaction effect between proficiency in English and the other languages, which directly impacted app use. Our findings suggest that these rather sophisticated digital and language learning students make sophisticated choices of apps based on knowledge of apps and the language learning task at hand.

Keywords: language apps, language learning, second foreign languages, less commonly taught languages, English

1. Introduction

Language learning methodologies have undergone major shifts within the last decade. The sole reliance on printed materials has been seriously challenged by electronic resources that have become available on the internet (Benson and Chik, 2010, Sockett, 2014). While most language learning in developed countries still takes place in traditional classroom settings and many students actually prefer to be taught that way (Trinder, 2016), the advent of technology-based learning has introduced new – and often innovative – methods to foreign language teaching methodology (Katyal and Evers, 2004). In particular the introduction of smartphone applications (so-called ‘apps’) into learning and teaching languages has brought with it new opportunities as well as challenges that will have an impact on learning and teaching methodology for decades to come (Dakowska, 2018; Rosell-Aguilar, 2017). Digital learning tools can go beyond what is commonly taught in classrooms and incorporate features that focus on specific aspects of the language learning experience (Beetham and Sharpe, 2007), for instance, pronunciation or intensive vocabulary training (i.e., Duolingo or Sounds: The Pronunciation App). In addition, digital language resources may contain more current contents on language use, whereas textbooks are typically older. The specialization as well as up-to-dateness of electronic learning resources appeals to many language learners and it has been suggested that advanced learners in particular can benefit from enhancing their learning via digital education (Green and Oxford, 1995, Leaver and Atwell, 2002, Lee, 2011, Lee and Markey, 2014). When researching the availability of smartphone apps for learning English as a second language, however, it becomes clear that the large majority of apps are designed not just for advanced but also (or exclusively) for beginning learners (see, e.g., British Council app recommendations: https://learnenglish.britishcouncil.org/apps/learnenglish-grammar-uk-edition). A central question, therefore, is whether the proficiency level that language learners have attained plays a role in their engagement with electronic online learning sources.

1.1 Digital Language Learning

Even though digital resources for language learning can offer possibilities that extend beyond traditional classroom methods, independent learning is not pursued equally by all students of foreign languages. Some studies show that ‘good learners’ tend to use more diverse learning strategies than do ‘poor’ language learners (Gerami and Baighlou, 2011, Griffith, 2008, Naiman et al., 1976). Effective language learning during adulthood can have many roots and causes (Dörnyei, 2010). Certainly, highly successful second language students...
emphasize more active involvement and naturalistic contexts of language practice (Green and Oxford, 1995), which might predispose them to the use of electronic resources as a supplement their learning.

Recent research has shown that unsupervised, extra-curricular online learning may enable learners to progress to a more advanced level of language proficiency as compared to those learners who exclusively rely on formal instruction (Cole, 2015). In particular, the use of informal online learning sources was strongly associated with higher motivation and proficiency (Cole, 2015). These findings run counter to a dominant paradigm in foreign language learning which prioritize expert regulation of learning environments and contents on the part of the teachers (see, e.g., Comas-Quinn, 2016, Farmer et al., 2011, Richard-Amato, 1988). In order to solve these incompatible views on how to best learn and teach foreign languages with the help of digital methods, more detailed studies are warranted to determine how independent, digital learning interacts with level of proficiency in a foreign language.

The present study aims to investigate the question of how prevalent and popular the use of digital language learning apps is among learners of different proficiency levels. Specifically, we are interested to see if higher proficiency and increased willingness to engage with digital means of language learning are correlated. In order to do so, we studied the learning methods with smartphone apps of foreign language students in one of the most digitally advanced societies – South Korea – where students are especially inclined to use learning technologies. We included students who had only recently started to learn a foreign language, as well as advanced language learners in our sample to see how useful learners of different proficiency levels find language learning apps. In addition, we investigated whether the particular language studied (English, German, Hausa, Swahili or Zulu) had an impact on students’ digital learning habits. In sum, these research objectives can help find answers to the larger question of which particular demographic it is that uses smartphone apps for language learning and what these users’ expectations are with regard to availability and functionality of language apps.

1.2 The Korean Context

South Korea is one of the most technology-savvy societies, with the widest internet availability and fastest internet connectivity in the industrialized world (Akamai Technologies, 2017, Broadband Commission for Sustainable Development, 2016). Especially the younger generation of Koreans readily incorporates technologies into their everyday lives, and smartphones have become the electronic appliance that people rely on the most (Park et al., 2013, Shin et al., 2011). The gamut of functions for which smartphone apps are used ranges from online-shopping, smoking cessation programs, and monitoring of health to checking air quality or maintaining social contacts via KakaoTalk, among many more (Kim et al., 2013). Currently, Korea ranks third (after China and India) in terms of average number of apps used per month (App Annie, 2017). It therefore comes as no surprise that Koreans would incorporate technology heavily into their educational regimens as well and supplement their learning with apps (Luef, Ghebru, and Ilon, 2018).

Studying foreign languages has a long and geo-politically interesting history in South Korea (see Lee, 2003) where the majority of people speak at least one foreign language (typically English) at an advanced level (Park, 2009). English is the primary foreign language that is taught in Korean schools and high proficiency in the language is a prerequisite for university admission (Park, 2009). Among Asian countries, Korea currently ranks sixth in the proficiency index of English as a second language – just behind Hong Kong (see E.F. Report, 2018) – and among the younger generation, proficiency is even higher than the population mean (Butler, 2015). Other foreign languages that are part of the high school curriculum include a number of European languages (e.g., German, French, and Spanish) and Asian languages (e.g., Japanese, Chinese). The high value of foreign language education in Korea becomes evident by the existence of foreign language high schools and a university that focuses on foreign languages (Hankuk University of Foreign Studies).

Seoul National University (hereinafter SNU) was founded in 1946 and is widely considered the premier university of the country (see Times Higher Education Ranking for 2018). The German Education Department at the College of Education provides a German program for students training to become teachers of the language. Admission of students to the program is based on a rigorous selection process where the majority of new students have previous knowledge of German. A certain percentage will be admitted, however, without prior knowledge of the language. This results in a heterogeneous student body, which may be considered as a hot bed in terms of autonomous learning methodologies. Digital learning strategies can assist students of lesser proficiency to accelerate their learning processes and attempt to catch up with the more proficient
students in their program. As German ranks among the top four of the most popular foreign languages (Ammon, 2015), a large variety of digital resources, many free of charge, are available for interested students.

A largely different picture emerges for students at the African Studies program at Hankuk University of Foreign Studies (hereinafter HUFS), a private university founded in 1954. Famous for its specialization in foreign languages, the African Studies program was introduced in 1982, with Swahili as the pioneer language, followed by Hausa and Zulu. All students who are admitted to the program have little or no prior knowledge of Swahili, Hausa or Zulu (hereinafter referred to as ‘African languages’). In this regard, the student body is largely homogenous. Digital technologies can be beneficial to beginners of a language by providing them with opportunities to speed up their learning and progress faster toward their learning goals. Considering that the majority of students in African languages at HUFS have little knowledge of the languages, they can benefit from available language apps. However, a smaller learning community for African languages and, therefore, fewer digital resources can have detrimental effects on how students engage with electronic learning material.

In general, Korean students are experienced and eager language learners and, given their culturally-driven preferences for technology, they provide good models for studying the education-technology interface in language learning (Luef et al., 2018). With language learning apps, as with any new development, it is important to make predictions concerning future trends to be able to adapt to what learners will likely expect from the technology in the years to come. Language learning technology is shaping up to play a large role for education in the future and thus its use and applications need to be understood by researchers today. Investigating societies who are at the forefront of digital learning – such as South Korea – can help chart a reliable course of where learning technologies should be headed and what requirements the language learners of tomorrow demand from their digital learning sources. The aim of the present study was to investigate the use of new electronic language learning applications (so-called ‘apps’) by students of different foreign languages at two Korean universities. Our interest was to see which learners engaged with which learning apps. Additionally, we wanted to see if there were differences that related to which foreign language was studied and how the language was studied. The following research questions were explored:

1. Which learners – with regard to proficiency levels – engage with which learning apps?
2. Are there differences that relate to which foreign language was studied?
3. What was the particular method how the language was studied?

2. Methods

We focused on two aspects that we predicted to have an impact on the use of language apps: (a) the proficiency level a learner has in learning their second (or subsequent) foreign language, and (b) the interaction between proficiency levels in English (first foreign language) and second (or subsequent) foreign languages (i.e., English with either German, Hausa, Zulu, or Swahili). Although, for many students, the study of German or an African language may well be their fourth or even fifth language, for purposes of this article, we will refer to the study of this language as a second foreign language for purposes of ease of use. We evaluated whether the mode of language learning (in class, online, study abroad) had an influence on how students interacted with online learning apps.

2.1 Participants

Forty-three undergraduate students of German Education at SNU and thirty-nine undergraduate students of African languages (with majors in Swahili, Hausa, or Zulu) from HUFS participated in our study (N=82). Participants took classes at the respective departments during the spring semester 2017 and were recruited through a combination of purposive and convenience non-probability sampling (see, e.g., Schreuder, Gregoire, and Weyer, 2001). A number of classes during the spring semester 2017 were pre-selected and all enrolled students were asked to take part in our study. The chosen sampling techniques allowed us to identify and recruit suitable participants (i.e., students studying English and one of the other investigated languages) while, at the same time, retaining some level of randomness (as no students of the selected classes were excluded). The mean age for German students was 21.7 years; the mean age for students of African languages was 22.9 years. The majority of participants were female (German: 30 or 69.8%; African languages: 26 or 66.7%). All were recent graduates from secondary schools.
Participants completed two questionnaires; one collected information on apps they used generally and for language learning, and the other questionnaire collected demographic and individual information about their language learning experiences and status. Data collection was conducted between March and May 2017.

2.2 Questionnaires

The demographic questionnaire collected information about how long students had been studying English and the second foreign language they were majoring in, how long they had been in their respective language program at their university, how proficient they rated themselves to be in English and their second foreign language, how proficient they rated themselves in those languages with regards to the proficiency of their classmates, and how often they were in contact with native speakers of the languages. The apps questionnaire asked which apps they used for which languages, how much time per week they spent using an app, and how useful they rated each app for their language. We excluded apps that were downloaded but never used from our sample. The two questionnaires were matched for individuals. One was done in class and the other online.

The questionnaires were in English as all students were proficient in the language. Furthermore, all students owned a type of smartphone. The questionnaire covered almost all students in each of the classes and there was 100 percent participation. No students were eliminated due to absence, lack of smartphone or incomplete questionnaire. We were able to get back to any students who had not completed the questionnaire initially and ask them to complete it within a short period of time.

2.3 Statistical Methods

Although we had the necessary variety of students who were using smartphones and taking classes majoring in various languages, we had an additional challenge. Given the nature of the programs and classes under study, the students were not automatically sorted by their proficiency in the language they were studying. We had no objective measure of proficiency. Yet our ability to study the impact of proficiency on the use of language apps was dependent upon classifying students by proficiency levels. Nevertheless, students have a fair idea of their own proficiency relative to others. To solve this problem, we included several possible proxy measures of proficiency in our questionnaire to students. For determining proficiency we therefore asked several questions: (a) how students rated themselves on proficiency, (b) how they compared themselves to their classmates in terms of language proficiency, (c) the number of years students had spent in the language program, and (d) the number of years students had spent studying the language. Table 1 shows the proxy measures (questions), how we measured them and a shortened reference name we will use to explain how we developed a composite proxy measure.

Table 1: Proficiency questions

<table>
<thead>
<tr>
<th>Proxy measure (question)</th>
<th>Measurement scale</th>
<th>Shortened name</th>
</tr>
</thead>
<tbody>
<tr>
<td>In which year of your foreign-language studies are you?</td>
<td>Measured in years</td>
<td>Years in language program</td>
</tr>
<tr>
<td>For how long have you been studying the language that you are majoring in?</td>
<td>Measured in years</td>
<td>Years studying language</td>
</tr>
<tr>
<td>How good are you in the foreign language you are majoring in?</td>
<td>1=beginner 2=low proficiency 3=medium 4=good 5=excellent</td>
<td>Self-evaluation concerning language proficiency</td>
</tr>
<tr>
<td>Compared to the other students in your class, how good are you in the foreign language you are majoring in?</td>
<td>1=less than the others 2=as good as the others 3=better than most</td>
<td>Self-evaluation compared to other students</td>
</tr>
<tr>
<td>Have you been to a country where the language is spoken for more than a semester?</td>
<td>1= no 2= yes</td>
<td>Travel in country of language</td>
</tr>
</tbody>
</table>

We were not sure which of these self-report measures would be reasonable to build a composite measure. Thus, in order to build a composite variable for proficiency, we began by looking to see which of these five measures were correlated. Our assumption was that, if modestly correlated (positively or negatively), then they were likely different measures of the same construct – language proficiency. Table 2 shows the bivariate correlations:
Table 2: Correlations amongst proficiency measures

<table>
<thead>
<tr>
<th></th>
<th>Years studying language</th>
<th>Self-evaluation compared to other students.</th>
<th>Self-evaluation concerning language proficiency.</th>
<th>Years in language program.</th>
<th>Travel in country of language.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years studying language</td>
<td>x</td>
<td>.64</td>
<td>.76</td>
<td></td>
<td>.17</td>
</tr>
<tr>
<td>Self-evaluation compared to other students.</td>
<td>.64</td>
<td>x</td>
<td>.67</td>
<td>-.07</td>
<td>.44</td>
</tr>
<tr>
<td>Self-evaluation concerning language proficiency.</td>
<td>.76</td>
<td>.67</td>
<td>x</td>
<td>.06</td>
<td>.50</td>
</tr>
<tr>
<td>Years in language program.</td>
<td>.17</td>
<td>.06</td>
<td>.10</td>
<td>x</td>
<td>.21</td>
</tr>
<tr>
<td>Travel in country of language.</td>
<td>.21</td>
<td>.44</td>
<td>.50</td>
<td>.21</td>
<td>x</td>
</tr>
</tbody>
</table>

Correlations over .5 occur among three variables, years of studying the language, self-evaluation concerning language proficiency, and self-evaluation compared to other students. We used these three variables to comprise the composite.

Since all three variables chosen to form the composite had different measurements and different distributions, we began by standardizing each measurement. We used z-scores to standardize the means and standard deviations of each of the three chosen variables. We then averaged the three together to get a composite (we added a constant “5” to get a mean of five and a standard deviation of one simply because we preferred a composite with positive values; this monotonic transformation has no bearing on results.). We now had a proficiency variable that was a continuous measure.

Because our goal is to reveal patterns of responses relative to apps, we built one more variable. We used our composite proficiency variable to build proficiency groupings. To do so, we first ordered all respondents by their score on the proficiency measure. We then divided them into four groups by looking for natural breaks among the proficiency scores. This resulted in grouping that, while grouping like people together, had groups of different sizes. The distribution fits, roughly, what might be expected of a normal distribution of proficiency. Table 3 shows the ranges of proficiency scores and numbers of respondents in each proficiency group.

Table 3: Second foreign language proficiency groups

<table>
<thead>
<tr>
<th>Proficiency group</th>
<th>Range of proficiency scores</th>
<th>Avg. proficiency compared total sample</th>
<th>Number in group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Beginning</td>
<td>4.11-4.11</td>
<td>19th percentile</td>
<td>15</td>
</tr>
<tr>
<td>2 - Low</td>
<td>4.30-5.16</td>
<td>28th percentile</td>
<td>37</td>
</tr>
<tr>
<td>3 - Medium</td>
<td>5.35-5.85</td>
<td>70th percentile</td>
<td>21</td>
</tr>
<tr>
<td>4 - High</td>
<td>6.22-7.67</td>
<td>98th percentile</td>
<td>9</td>
</tr>
</tbody>
</table>

Using these two derived proficiency measures (proficiency scores and proficiency groups), we were able to assess patterns in the rest of the questionnaire.

In a similar way, we created composite scores from self-reported English ability. There were five questions asked – we used three of them given intercorrelations. Those questions were (1) For how long have you been studying English?, (2) What is your level of proficiency in English?, (3) Compared to the other students in your class, how good are you in English?, and (4) Have you been to a country where English is spoken for more than a semester? We standardized, created a composite, and then added “5” to the score to bring z-scores into the positive range. Table 4 shows the results.
Table 4: English language proficiency

<table>
<thead>
<tr>
<th>Standardized proficiency score</th>
<th>z-score equivalent</th>
<th>Avg. proficiency compared to total sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.00</td>
<td>-2.00</td>
<td>5th percentile</td>
</tr>
<tr>
<td>4.00</td>
<td>-1.00</td>
<td>31st percentile</td>
</tr>
<tr>
<td>5.00</td>
<td>0.00</td>
<td>50th percentile</td>
</tr>
<tr>
<td>6.00</td>
<td>1.00</td>
<td>68th percentile</td>
</tr>
<tr>
<td>7.00</td>
<td>2.00</td>
<td>95th percentile</td>
</tr>
</tbody>
</table>

3. Results and Discussion

Proficiency was not distributed evenly across all language groups. It is interesting to note that one of the three African language (Hausa) stood out as having a relatively large number of students who rated themselves as beginners. The other two African languages and German had less than 20 percent of students who were rated as beginning students (see Table 5).

Table 5: Number of students in each proficiency group by language

<table>
<thead>
<tr>
<th>Language</th>
<th>Beginning</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>German</td>
<td>5</td>
<td>13</td>
<td>16</td>
<td>9</td>
<td>43</td>
</tr>
<tr>
<td>Zulu</td>
<td>12%</td>
<td>30%</td>
<td>37%</td>
<td>21%</td>
<td>100%</td>
</tr>
<tr>
<td>Swahili</td>
<td>12%</td>
<td>71%</td>
<td>18%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Hausa</td>
<td>13%</td>
<td>75%</td>
<td>13%</td>
<td>7%</td>
<td>100%</td>
</tr>
<tr>
<td>All Languages</td>
<td>15%</td>
<td>37%</td>
<td>21%</td>
<td>11%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The 82 students from the two schools who took the questionnaire were categorized into proficiency groups, as shown in Table 4, ranging from beginner level to high proficiency level. More than 70 percent of the total students that participated in the study turned out to be in the low and medium levels. This means they were, at most, in their first and second year of the language programs. The highly proficient students were only among the German program students. Only about a fifth of the German language learners were rated in the high proficiency category while none of the African language learners were at a high proficiency level.

How did these proficiency levels affect language learning app used, if at all? Students generally feel as if they learn language through formal education. Yet, many have apps on their smartphone which assist in language learning. Table 6 shows how students in Korea depend upon their smartphones for many digital learning features.

Table 6: Number of language apps used by proficiency group

<table>
<thead>
<tr>
<th>Proficiency</th>
<th>Number of apps used for language learning</th>
<th>Number of apps used for foreign language learning</th>
<th>Percentage of apps actually used for foreign language learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning</td>
<td>2.7</td>
<td>1.7</td>
<td>63%</td>
</tr>
<tr>
<td>Low</td>
<td>3</td>
<td>1.6</td>
<td>53%</td>
</tr>
<tr>
<td>Medium</td>
<td>3.2</td>
<td>2</td>
<td>63%</td>
</tr>
<tr>
<td>Total</td>
<td>3.3</td>
<td>2</td>
<td>64%</td>
</tr>
</tbody>
</table>

We asked three questions regarding language learning apps on students’ phones. First, how many apps total did they have that they considered they could or did use for language learning. Second, which of these did
they use for English language learning? Third, which did they use for learning the new language? In many cases, students had downloaded many more apps than they actually used for both English and second foreign language learning.

The most obvious pattern in Table 5 is that those with the most proficiency have more language learning apps downloaded than those with lower levels of proficiency – nearly double the number. Also, high proficiency students tended to use most of their apps. They downloaded a variety of apps and used about 80 percent of them.

The highly proficient second foreign language learners were comprised of only students of German. We cannot exclude the possibility that the factor ‘highly proficient German learner’ played a more significant role leading to these results than the factor ‘highly proficient second foreign language learner’. Many of the highly proficient students of German had spent prolonged periods of time in Germany, either working or living there. Therefore their use of apps for language learning may be influenced by their experiences abroad to some degree. Inversely, the group of ‘beginning’ language learners consisted of 50% Hausa students and this may have biased the results toward their learning experience. Low app use in beginning students could have been driven by low app use in students of Hausa. Beginners and highly proficient language students are always, however, distinct groups of language learners and their experiences largely overlap regardless of which foreign language they have acquired (see, e.g., Dörnyei, 2010). Therefore the group of proficient German students can be seen as representative for proficient language learners and beginners of Hausa as representative for beginners of a second foreign language.

There are three possible reasons for why highly proficient language students use more apps than students of lower proficiency. First, these data might suggest that students’ motivation to use language apps increased with their skill level in the studied language. Advanced students could have more interest in actively working toward improving their already-good language skills, maybe aiming at becoming more native-like in their use of language. Learning motivation may rises with increasing success in the mastery of a skill and the increased use of language apps of highly proficient students in our data might reflect that general trend.

Second, higher language proficiency might offer more possibilities for students to engage with apps in an educational way. The majority of apps might be designed to train specific language features, which is generally more interesting to advanced students as they are better aware of their needs regarding their language learning. With a certain skill level in the foreign language, learners become more adept at figuring out what they do not know and need to practice more intensively, and apps that train specific nuances of a language are more useful to more proficient users. If more advanced students tend to hone their studies, their use of apps on their smartphones is more targeted. They know which apps help them, focus on specific apps and use them intensively. In addition, proficient language learners are exposed to a wider variety of social situations in which the foreign language can be used. They may read newspapers in the language or even talk to native speakers - something which is rarely done by beginners or intermediate language students. This expanded social range of language use might directly lead to an expanse in the use of apps, as these students would ultimately be able to use social media and apps such as Skype in a manner that is similar to how native speakers of a language are able to use such apps.

But there is another, third explanation. Many language learning apps are built to be used by users of major languages such as users who are native to English, Spanish or French, meaning the source language for the app is one of those languages. Thus, proficiency in a major world language helps in using language apps generally. It is possible that, as students advance in their second foreign language (given that Korean students are always learning English), they are also becoming more proficient in English. Their ability to benefit from language apps increases as their concomitant ability in English improves.

To investigate this, we looked at the relationship between English proficiency and second foreign language proficiency along with the average number of apps used in language learning as in Figure 1. More proficient students in English language did well in their second foreign language proficiency as well. At the same time, students who are good at English generally used more language learning apps – with the exception of students with the lowest English proficiency.

www.ejel.org
Figure 1 shows that there is a relationship between very low and very high proficiency in both languages and more intensive app use. Students who were highly proficient in English were also generally highly proficient in their second foreign language and, at the same time, used a higher number of apps for language learning. The one exception to this overall trend was that low proficiency language learners tended to use more apps (than medium level learners, but not higher proficiency learners). Note that Figure 1 shows a slightly different result than that of Table 5. Table 5 categorized students by their proficiency in their second foreign language, whereas Figure 1 categorized students by their self-reported English language proficiency. In both cases, the general trend was that, the more proficient they were in language, the more apps they used. But, with English language learners, the lowest level users were an exception where they were somewhat more likely to use apps than the medium level proficiency English language learners. This may well be an anomaly given our sample size and the small differences in total apps used. But, it is also possible that apps use at the beginning level aids their below-average language skills.

Given that there is a fairly strong trend in using more apps the more proficient one is in a language – whether in their first or second foreign language – the question is, how likely is it that using apps is actually helpful in language learning? One might assume that this many students, who are clearly practiced in language learning and are comfortable with apps, are not making irrational decisions in downloading and using apps for language learning. But, another clue is in examining which apps are used. Table 7 shows which types of language apps are most widely used.

<table>
<thead>
<tr>
<th>App category</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dictionary</td>
<td>86</td>
</tr>
<tr>
<td>video</td>
<td>39</td>
</tr>
<tr>
<td>SNS</td>
<td>37</td>
</tr>
<tr>
<td>Translator</td>
<td>37</td>
</tr>
<tr>
<td>Portal app</td>
<td>27</td>
</tr>
<tr>
<td>Language learning app</td>
<td>21</td>
</tr>
<tr>
<td>Podcast</td>
<td>11</td>
</tr>
<tr>
<td>News</td>
<td>7</td>
</tr>
<tr>
<td>Book</td>
<td>4</td>
</tr>
<tr>
<td>Radio</td>
<td>4</td>
</tr>
<tr>
<td>Music app</td>
<td>2</td>
</tr>
<tr>
<td>Note/Memo</td>
<td>2</td>
</tr>
<tr>
<td>Forum</td>
<td>1</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>278</strong></td>
</tr>
</tbody>
</table>
Students were asked to name each of the apps on their smartphone that they used, at least in some manner, for helping them learn a language. A large list of apps was obtained. We built a list by name and then categorized this list. Table 6 shows the 13 categories which resulted. Not surprisingly, dictionaries were the most widely used followed by video players, translators, and messaging (SNS) apps. SNS apps were identified to be used mostly by German language students while African language learners tended to use translator and dictionary apps. Several of the portal websites incorporate dictionary and translator functions. For example, a local Korean website called Naver incorporates dictionaries of many languages. This is in contrast to Google, for example, which creates individual apps for dictionaries and translators. These are popular portals and, given that Korea has cheap, high speed and ubiquitous cell network access, they operate effortlessly. This made it difficult to judge whether to categorize these named apps as separate apps or consider them a bundle as a portal app.

These categories of apps are also useful in the analysis of proficiency. Did the variety of categories of apps also vary by proficiency? We examined this in Figure 2, which shows that the variety of apps also grows as students become more proficient in the language they are studying.

**Figure 2: Average number of categories by proficiency group.**

Generally, more than four diverse types of the app categories were used by highly proficient students. So, not only are more proficient students using more apps, they are using a larger variety of apps. It is not just that they are searching for more or better apps in the same category, but that they are looking for more diverse ways of exposing themselves to the language through apps.

There was a small but steady increase in app types among the lower proficiency groups (beginning, low, medium proficiency) but a relatively sudden jump from medium (2.5 app types) to high proficiency (4.1 app types). There is also a possibility that the higher number of app categories we found in the highly proficient group (of students of German) is linked to the larger variety of apps available for learning German relative to those available for learning the African languages.

As language learning gets more advanced, the contents covered increases substantially. While beginning students are limited in their use of vocabulary and grammar, proficient language students have a much larger range and amount of language learning contents that they absorb. Complexity of language learning topics increases dramatically as students reach a higher proficiency level, for instance the nuances of tenses in German or dialectal variations of Swahili. Thus a larger number of apps in total and app categories may be incorporated into the learning procedures by proficient students.

Thus, high proficiency students may be able to benefit from a broader range of app types as they can, for instance, chat via SNS messengers with their German friends or enjoy German videos on YouTube. Beginning and intermediate language learners are more restricted in what foreign language contents they can access and use in a meaningful way. In addition, the majority of advanced German students had a history of living or studying in Germany and had made acquaintances and friends there with which they stayed in contact via different communication apps. Beginners of a language tend to have less of a social network and cultural
connection to the country where the language is spoken - a fact which may restrict them somewhat in their use of electronic apps, such as Skype or SNS messengers.

This result certainly shows that there is a relationship between the use of apps and the proficiency language learning. However, we cannot determine causation. Even though the use of apps is clearly a strategy incorporated as a tool for helping to master a new language, we asked how much of the new digital learning tools are used by students.

Students estimated how much of their language mastery they could attribute to classroom learning, online learning and visiting the country of the language (or other means). We recognized, in asking, that their answers would be substantially subjective, yet such answers would give us some measure of the impact of online learning. Their responses were, in fact, instructive.

As we expected, across all the proficiency groups, classroom learning dominated the language learning process. However, a close look at the percentage of language learning spent online across proficiency groups shows a surprising outcome as in Figure 3 below. Relatively, students with lower language proficiency reported spending more time using online language learning tools than those at the higher proficiency level.

![Figure 3: Percentage of online learning by proficiency group.](image)

Lower proficiency students tended to learn more from online/app methods. Specifically, they attributed 25% of their language mastery to online learning, whereas medium and high proficiency learners reported only 9.5% of their learning to have come from online sources. This finding is particularly interesting given what we found in the earlier tables (Table 5, Table 6) and Figure 2. Those showed a tendency of more proficient groups to use more apps and more variety of apps. Figure 3 shows that it is the beginner group that feels their mastery of the language can be attributed more to online sources than to classrooms or real world experiences — relative to more proficient groups. The interpretation would be that beginning groups are very focused — possibly turning to vocabulary and, possibly one language learning app or software. They spend a lot of time using this and feel that they learn a lot from these online tools. More proficient groups span out, incorporate more variety, but also incorporate more real-life and classroom experiences.

Why this is so is less clear. This is an area that needs more exploration. We have several speculations. First, beginning students may be younger and may be more prone to digital learning solutions. Online language instruction is getting more sophisticated and younger students may investigate ways to learn languages online as a flexible, self-paced way to learn a language. In language classes where students have mixed competencies, beginners may find that online resources are a good supplement to help them catch-up or keep-up with more advanced students. It is possible that all students used the same online resources, but more advanced students learn less from those resources as a means of completing their assigned classroom tasks.

### 4. Conclusions

The present study aimed to investigate whether the use of smartphone apps for language learning was influenced by linguistic proficiency of the learners and, further, whether proficiency levels in different first and
second foreign languages showed some interaction concerning the learners’ propensity for app use. In addition, the particular method of how a language is learned (online, abroad, in class) was also investigated in order to predict app use in foreign language students.

The findings suggest that what might seem to be a simple correlation between apps use and foreign language study is more nuanced when examined in detail. Although the present study is limited by its small sample and the short range of second d foreign languages, it is the context of the study which sets the findings in the most interesting light. We looked at students in two of Korea’s universities most suited for the study – its top university and the university specializing in foreign language study. Further, Korea is one of the most high-tech countries in the world where students regularly use technology to supplement their studies and have ubiquitous access to and readily use the internet and smartphones. Finally, these are exceptionally practiced language learners at the outset. In order simply to be admitted to the universities, they have to have scored very competitively on a college entrance exam in the English sub test – they have already mastered a second language. So, the predominant question is: how do these students, largely at the cutting edge of technology and language learning, use apps to supplement their second foreign language learning?

The results are nuanced but very informative as the world moves to online learning. First, more proficient groups tend to reach out to online sources and apps to extend their learning of language. As Table 6 demonstrated, the variety of apps used is extensive and, perhaps, even a bit surprising – video apps, music apps, news apps. So, on the one hand, as language reaches higher levels of mastery, apps appear to become a window into both a language and a culture and a means of reaching into a variety of ways of exposure.

Yet, on the other hand, beginning learners of a language showed almost the opposite pattern. Whereas they neither download nor use very many apps for learning language, they do report that their mastery of language comes, substantially, from online sources. They may not be using many apps, but there are using online sources to learn the language. These sources go beyond a mere supplement (dictionaries and translators), but are clearly an instructional tool. If our results can be trusted, then their attention is focused on extensive online sources to learn the language. These sources go beyond a mere supplement (dictionaries and translators), but are clearly an instructional tool. If our results can be trusted, then their attention is focused on these online sources of learning (Figure 3).

There are other nuances. It is possible that with rising competence in a language, the learners become more critical of the educational efficacy of apps and may use only certain parts of apps. This can easily mean that a large variety of language apps are downloaded, possibly even accessed on a regular basis. No app, however, is used exhaustively. Experienced language learners may also be experienced language learning tool evaluators. They know what they want, they search for it, and they use the tools in a targeted way. The language learning consumer is increasingly influencing the market for language learning tools.

Finally, another global problem is probably at play among this experienced Korean population. The fact that most apps require students to have a good command of English to navigate through them could have an influence here. As Figure 1 showed, there was minor relationship between English language proficiency and second foreign language proficiency. The relationship is weak, but may be relevant for purposes of this discussion. Since language learning apps tend to be more available in major world language (often Western languages), it is germane to ask whether competence in one of these major world languages might also be a factor in using language learning apps. Future research should focus on questions, such as: Would the fact that many of these apps are designed to be used by English speakers hinder students from looking for them and downloading them on English websites? Are online tools and apps, global and networked as they are throughout the world, partly a function of whether one has, at the outset, already mastered a major world language – access to Urdu begins with mastering English, for example? Additionally, more apps that are customized to learners of certain proficiencies are needed to increase the levels of language app engagement in beginners as well as intermediate and advanced students of a foreign language.

What should certainly be discussed in the context of online/app learning is how app learning is characterized within the framework of language methodology. An important factor is that this methodology of studying can be rather solitary (depending on which apps are used), as opposed to studying with traditional textbooks in study groups with fellow students. Advanced students might be able to better deal with a lack of social environment during studying sessions than beginner students who might need more social feedback. The
social environment that is imposed by app use can be rather unique, considering the fact that language apps are frequently used when students wait for a bus or become bored travelling. In such instances, the learner is alone with the educational content. This type of learning might be more conductive to how advanced students approach studying a language but could seem less attractive to beginning and intermediate language learners. On the other hand, certain apps can be used to learn collaboratively in study groups and the use of SNS certainly hints at some form of social learning.

Furthermore, the role of linguistic complexity should not be underestimated when discussing online language learning. Complicated linguistic structures may be hard to discern from a purely written description (as can be found in most apps). Therefore, app contents could be more accessible to advanced students who have previous knowledge of a linguistically complex problem. This could easily result in advanced students engaging more actively with language apps.

Our research has implications for language learning methodology and can advise educators wishing to encourage their students to use more electronic resources when studying a foreign language. As shown by our data, higher motivation to do so can be found among proficient students, while it may be more difficult to get students of lesser proficiency to overcome their inhibitions to learn online. Beginning students, on the other hand, seem to obtain more content from online resources than advanced students. Focusing on the benefits and advantages that are offered by electronic learning tools, while at the same time mediating the reservations some students may have about learning apps, can lead to more successful commitment of students of all proficiency levels with new learning technologies.

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References


Evaluation of a MOOC Design Mapping Framework (MDMF): Experiences of Academics and Learning Technologists

John Kerr, Vicki H.M. Dale and Fanni Gyurko
The University of Glasgow, Glasgow, UK
john.kerr.2@glasgow.ac.uk
vicki.dale@glasgow.ac.uk
f.gyurko.1@research.gla.ac.uk

Abstract: With the increasing strategic importance of Massive Online Open Courses (MOOCs) in higher education, this paper offers an innovative approach to advancing discussions and practice around MOOC learning design, in the context of staff development. The study provides a deeper understanding of staff (academic and learning technologists') experience when designing MOOCs, through the evaluation of a novel MOOC design mapping framework (MDMF) at one higher education institution. The MDMF was developed to enhance the MOOC design process for staff involved, providing dedicated, tailored support in this area. This study considers and contributes to the literature on learning design, differences between face-to-face and online learning and the role played by academics and learning technologists in the design of MOOCs. The study is based on rich qualitative data drawn from 12 semi-structured interviews with nine academics and three learning technologists who used the framework for constructing MOOCs. This study evaluates: (1) how the framework was used and supported; (2) benefits of the framework to support good practice in learning design and the design process; and (3) limitations of the framework. We also considered suggested enhancements to the framework. The study highlighted new areas that could influence the design process, such as the importance of the learning technologist as a facilitator of the MDMF, the benefits of the visual aspects of the framework, technological challenges, and users' level of digital literacy.

Keywords: Learning Design, MOOCs, Online Learning, Curriculum Development, Academic Development, Learning Technologists

1. Introduction

MOOCs have seen year-on-year growth since their inception with an estimated 60 million registered users across the major platforms (Shah, 2016). Despite reservations about their life span (Haggard et al., 2013), MOOCs are shifting position and are now part of the fabric that make up institutional online offerings. Therefore, we recognise that MOOCs have a growing importance in university curricula as a way of advancing degree offerings and providing greater flexibility to those who want to learn (The Open University, 2017). As a result, universities aim to develop a sustainable MOOC business model within their institution (Daniel, Vázquez Cano and Gisbert Cervera, 2015, Epelboin, 2017). Following this trend, an innovative MOOC design mapping framework (MDMF) was developed by the first author (JK) to improve the MOOC design process for the staff involved at one higher education institution.

Research on MOOCs focuses on two main areas: firstly, the diverse rationale of why institutions have entered the MOOC space (Jansen and Konings, 2017), and secondly the impact of MOOCs on end-users (Christensen et al., 2013, Kerr et al., 2015). However, there is a gap in the literature in terms of how staff can be best supported to design MOOCs. As MOOCs become common practice within institutions, they become more resource-intensive and require a significant number of stakeholders to support and condition their expansion into a mainstream activity (Alario-Hoyos et al., 2014, Kerr et al., 2015). Goodyear (2015) argues that institutions need to invest more in the planning phase of curriculum design. Therefore, the overall aim of this study is to understand how the MDMF is used by academics, and supported by learning technologists, in the design of a MOOC. In particular, the paper presents the use of a novel online tool to aid learning design conversations and product. In the rest of this paper, we relay relevant literature as a background to our study, before outlining our methodology and outcomes from our evaluation, as they relate to how the framework was used, its benefits, limitations and suggested enhancements.
2. Literature review

For a deeper understanding of the MOOC design process, it is important to consider and summarise the research on the differences between online and face-to-face design, curriculum design, learning design frameworks, and the role of academic staff and learning technologists in the design process.

MOOC design differs from the standard approach to online course design, with the vast difference in cohort size and level of subject knowledge being the main differences (Jansen, Rosewell and Kear, 2017). Pedagogical issues arise when educators need to change their mindset from face-to-face and online courses (Hill, 2012) since in MOOCs they teach to a massive number of learners from different countries, with different backgrounds, statuses and motivations (Kerr et al., 2015). Moreover, each institution – and indeed schools within institutions – have their own approach to curriculum design; using processes developed in line with local practices.

Curriculum design is a process in which a course – or segments of a degree programme – are constructed with a holistic overview (American Association for the Advancement of Science, n.d.). This process involves the sequencing of learning activities coupled with resources, pedagogies, technologies and methodologies into a coherent structure (Hamza, n.d.). Although MOOC design is comparable to the design of traditional courses, it can often draw upon a greater number of internal stakeholders, e.g. academics, digital education team, media production, academic developers, and social media teams (UACES, n.d.). Therefore, institutions require guidance such as a framework which allows these diverse teams to work in tandem to support course design. The design of a MOOC, like the design of any other course (face-to-face or online), can be addressed from the perspective of learning design (Conole, 2009). Learning design provides tools and methods for articulating and representing the structure and sequence of learning activities, making them more explicit and shareable (Conole and Wills, 2013). This is a creative procedure which can go through several iterations, involving staff time and desire to learn new pedagogical and technological approaches (Koehler et al., 2004). Academic staff rely on prior knowledge in their design practice, which may not be problematic where the context is known, but this approach can cause difficulties when tasked to design courses using new pedagogies and learning technologies (Conole, 2009). There is a wide range of generic learning design approaches currently being deployed. For example, the ABC learning design toolkit (Perović and Young, 2015), based on Laurillard’s (2012) learning types, the 7Cs framework (Conole, 2014), the Carpe Diem approach (Salmon, Jones and Armellini, 2008), all of which are paper-based, visual approaches that can be applied to any course design, typically facilitated by a learning technologist in a face-to-face workshop. The 7Cs model has also been considered relevant to MOOC design (Conole, 2015) Similarly, Mor et al. (2016) deployed group-based workshops to support MOOC curriculum design, creating and reusing a set of sharable learning designs, based on earlier learning design work (Mor and Mogilevsky, 2013). That face-to-face activity focused on areas such as learner personas, storyboarding and reflective discussions to support staff in their design thinking.

The literature – which informed the development of the MDMF – points to visual design acting as a strong influencer for engagement and collaborative building. Hernández-Leo et al. (2007) suggested the idea that providing visual approaches is a good solution for supporting reflective communication and creative generation of designs, while Osterwalder and Pigneur (2010) noted that being able to work collaboratively on a visual representation enhances dialogue, improves communication among participants, triggers new ideas and allows participants to depict ‘the big picture’ design overview at a glance. Building on this theory, Alario-Hoyos et al. (2014) created an early-stage conceptual framework for educators to describe and design MOOCs from scratch, called the MOOC Canvas. That visual framework offers a visual representation of issues to guide educators throughout the MOOC design process, helping them to reflect on and discuss these issues via specific question prompts.

There are a considerable number of stakeholders involved in the design and implementation of a MOOC, from academic staff to facilitators and the learners themselves (Kerr et al., 2015, McAuley et al., 2010). Academic staff reported that setting up a MOOC for the first time is a time-consuming process; a survey conducted by Kolowich (2013) concluded that a MOOC typically takes over 100 hours’ design time. Alario-Hoyos et al. (2014) argued that there is a strong relationship between logistical issues that academic staff have to face when balancing MOOC designing and normal duties, such as research and traditional teaching and design decisions. The technological issue also plays an important part and educators should be clear about the constraints of the platform they will use to run MOOCs (Alario-Hoyos et al., 2014). Recognising the growing importance of
MOOCs and the challenges around designing a MOOC, the first author (JK) developed a MOOC design mapping framework (MDMF).

3. Methodology

3.1 Overview of the MDMF

The MDMF takes its inspiration from several well-known frameworks and learning design concept models. The framework takes the form of a visual, online web resource, produced using RealTimeBoard, a free online solution which allows many collaborators to interact with a virtual design board.

The technological-pedagogical solution for the MDMF was extensively explored before a choice was made. Several design approaches were reviewed, including the online Trello platform for online project management, the paper-based ABC framework (Perović and Young, 2015), and the paper-based Carpe Diem approach (Salmon and Wright, 2014). It was perceived there was an opportunity to enhance the value of paper-based frameworks, by creating a fully online framework to support MOOC curriculum design that could be collaboratively authored by the MOOC teams.

The learning types underpinning the MDMF have been based on the ABC curriculum design framework of Perović and Young (2015), itself based on Laurillard’s (2012) different learning types (acquisition, discussion, practice, investigation, production, and collaboration). We have tailored these learning types to suit MOOC-led activities while digitising the end-to-end process. This was achieved through integrating these learning types and the FutureLearn activity types (e.g. videos, audio, articles, discussion, quizzes, peer review, assignments) in RealTimeBoard. Building on the open access ethos of Perović and Young (2015), all materials are Creative Commons licenced to enhance transferability.

Images 1 and 2 provide a visual overview of an empty board and a competed board. To populate the board (centre segment, Figure 2), a virtual post-it note is added to the appropriate activity section and is annotated with a step number and text providing a high-level description of the task. This is repeated to complete the design board. Once complete, that structure is then transposed onto the linear structure (left segment) with timings, before being mapped onto the ABC learning types (right segment).

Figure 1: Blank MOOC design map in RealTimeBoard
3.2 Context of the research

The University of Glasgow is a founding member of FutureLearn and to date has produced 30 MOOCs, attracting over 300,000 enrolments. MOOCs are seen as a driver of change at Glasgow through many facets, such as: enhancing staff digital literacies, and being a key contributor to our widening access to education agenda. MOOC developments have been distributed across the Colleges with many areas now standardising them within their online provision.

The MOOCs that were supported by the MDMF are generally of three weeks’ duration, with each of the academics designing one MOOC at a time. It is likely that the college-based learning technologists were designing multiple MOOCs within their collection of cognate disciplines. This requires working with a range of stakeholders as indicated in Figure 3.

3.3 Instrument for data collection

The primary method of data collection involved semi-structured interviews with nine academics and three learning technologists who used the MDMF framework for designing their courses. The participants were designing MOOCs for different subjects in Arts, Education, Humanities, Law, Medical, veterinary and life sciences, and the Careers Service at the University of Glasgow. The interviews were conducted by the third author (FG).
The demographics for the interview participants are shown in Table 1. In terms of sampling, purposive sampling was used (Cohen, Manion and Morrison, 2007) in the sense that we targeted those actively involved in MOOC design and development or who had recently completed this process. Academics were each involved in one MOOC at the time of this study whereas the learning technologists had experience of several MOOCs.

Table 1: demographics of interview participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Role</th>
<th>Experience of learning design framework</th>
<th>Experience of MOOC development</th>
</tr>
</thead>
<tbody>
<tr>
<td>P01</td>
<td>Academic</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P02</td>
<td>Academic</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P03</td>
<td>Academic</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>P04</td>
<td>Academic</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P05</td>
<td>Academic</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P06</td>
<td>Technologist</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>P07</td>
<td>Technologist</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>P08</td>
<td>Academic</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P09</td>
<td>Academic</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P10</td>
<td>Academic</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P11</td>
<td>Academic</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>P12</td>
<td>Technologist</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

A detailed interview schedule is included as Appendix 1. The semi-structured interview questions were tailored to the two types of participants – academics and learning technologists – and correspond with the aim of the research, focussing on topics congruent with the research questions. The semi-structured interviews standardised the questions to a degree, which allowed better comparison (Cohen and Crabtree, 2006). At the same time, participants were encouraged to discuss issues of personal significance.

Data collection took place between February and March 2018, and to encourage participation, we offered participants the choice of a face-to-face or online interview (both audio-recorded), or the opportunity to complete a written proforma. Eight interviews were conducted through Skype for Business, lasting between 8 and 17 minutes. Two interviews of similar timing were conducted face-to-face and the other two participants answered the questions via written interview proforma.

Ethical approval was granted by the University of Glasgow’s College of Social Sciences Ethics Committee (#400170071). Participants were invited to take part in the research via email, and were sent a plain language statement, consent form and interview proforma in advance of participation. Audio data were transcribed by an independent professional company, and transcripts reviewed for accuracy before being thematically analysed by using the approach advocated by Braun and Clarke (2006). These, and the interview transcripts, were initially read through and then read through again, with relevant text hand ‘coded’ electronically in MS Word by authors JK and FG. Codes were identified and grouped into categories. Author VHD independently coded the data in NVivo and then the researchers met to negotiate the final codes and categories. The overarching ‘themes’ are aligned with our original research questions. The themes and categories are represented here by the titles of the subsections in the next section of the paper.

4. Results

Four main themes were identified from analysis of the interview data:

1. How the framework was used and supported,
2. Benefits of the framework,
3. Limitations of the framework, and
4. Suggested enhancements.

Within each area, categories were identified around the process of using the MDMF, as well as learning design concepts. Additional categories identified included the role of the facilitator, the importance of visual elements of the framework, and technological challenges. Finally, we present the participants' perceptions on whether they would use the MDMF again and if it should be adopted as a standard for designing all MOOCs.
4.1 How the framework was used and supported

The main categories under this theme included process, learning design, and the role of the learning technologist.

4.1.1 Process

In general, academics had regular meetings with a learning technologist during the planning and design phase, while using the online MDMF to plan each week of content for the course. Academics suggested that they used the framework more for the initial design phase:

"I really only used it for the initial drafting of the course overall. As the course content developed in its later stages there was less need to use it ... since then I have reverted back to tables in word documents as my reference points for the course delivery." (P05, academic)

This means that the framework was useful as a starting point; however, in the later stages of course development some academics used more traditional techniques for the micro level detail.

From the learning technologists’ point of view, the framework and the workshops helped to monitor progress, serving as an unintended project management tool:

"It's handy for the other staff to understand where the MOOC is going as well, and kind of what information is needed that they need to work on as well." (P07, learning technologist)

One learning technologist also used the framework as a way to project manage tasks:

"...we then sat down and looked at [the workshop facilitator’s] template which it was really helpful because then we could just divide it up and say, right, you do that and I do that ... so that was really useful." (P08, academic)

The framework enhanced collaboration between academics and learning technologists and also across the academic team, as it provided a clear overview of the delivery process:

"It's beneficial for sharing information between the group and easy to change and a clear understanding of the processes of how the MOOCs are going to be delivered during the various weeks." (P07, learning technologist)

From the learning technologists' point of view, one of the most important aspects was that the framework could be used to encourage academics to think about the basics of the course before starting to explore the specifics:

"... what had happened is that staff members had been trying to create MOOCs and trying to kind of put it down on paper what they wanted to do with a MOOC and trying to plan it. They tried to write out sort of from A to Z with the plan of the MOOC and what I found was that the framework became very useful when we were able to say, look, you’re already thinking too far ahead of yourself, so we were able to use the framework to step back a bit and to think about tasks and then reorder and organise these tasks." (P06, learning technologist)

4.1.2 Learning design

Academic staff and learning technologists reported that they used the framework for selecting and sequencing learning activities and mapping content onto a structure:

"We used it to map out three weekly sessions and then inside each session to assemble a sequence of differently textured activities and resources as a way of planning a pedagogical sequence and helping us I suppose plan production of the various elements as well." (P03, academic)

One academic also noted that the framework served as good starting point to understand different learning types:
"I looked at the Learning Types and Tools to familiarise myself with the different types of learning, but I found the design map most useful." (P02, academic)

4.1.3 Role of the learning technologist as facilitator

The importance of the learning technologist as facilitator was a theme which emerged strongly from the data. Most participants mentioned that the inclusion of a learning technologist is critical to effective use of the MDMF:

"... sometimes when you're too knowledgeable or too immersed in a topic, you risk losing the learner's perspective, so it's useful to have someone who knows the structure of the MOOC, who knows the tool, but doesn't know much about the content because they can tell you ... you need to make it clear to people who are not experts in the field." (P11, academic)

One of the participants argued that without the workshop facilitator, the process of MOOC design would not have happened:

"Well, I wouldn’t say the effectiveness was in the computer tools as such, I would say it was more [the learning technologist’s] leadership and him managing us that made the conversations happen. So, I don’t know...put it this way, if we just had the tool and not [them], I don’t think it would have worked, but [they] sort of drove the framework for us ..." (P03, academic)

4.2 Benefits

The main categories under this theme included process, learning design, and visualisation.

4.2.1 Process

Designing a MOOC is a highly collaborative process involving several stakeholders. This collaboration aspect was strongly communicated by academics and learning technologists who noted that the framework resulted in increased collaboration between the teams:

"I think we all would still have met up for regular meetings however having something to focus on such as the framework made it so that everyone had a visual of what they were working on, which I think made collaboration better." (P01, academic)

The collaboration was also mentioned together with the design process as being highly creative:

"It’s a really good focus and as I said it was a kind of collaborative creative process. You’ve got to think outside the box quite a lot, you know, how to get simple ideas across to your audience." (P08, academic)

One learning technologist suggested that the framework is more effective as a collaboration enabler as the team complexity increases:

"I think it works better though when there’s more people on the planning team the better that it works, the more effective it is." (P06, learning technologist)

The framework also supported the learning technologist’s dialogue with academics:

"I think it’s really good because I think sometimes it is a struggle ... if they haven’t done any form of online learning, even blended learning. It’s very much a kind of blank canvas and it’s sometimes quite difficult to visualise how your face-to-face course would fit in an online environment." (P12, learning technologist)

Linked to the previous theme, learning technologists also suggested that the framework helped academics focus on aims and end goals:

"Instead of just sitting round and talking about what you want to achieve and how you’re going to achieve it, it’s quite nice to have something as a focus where you can actually have something that you"
can put together and have actually something physically at the end of it that can be photographed or forwarded round." (P12, technologist)

The following quote from an academic supports the previous suggestion:

"I think what it helped more was focus. Because collaboration we probably would have got anyway, whereas it's more difficult to actually focus on the structure and make things fit the structure..." (P11, academic)

Participants reported other benefits of the framework, such as being easy to use, efficiencies, and importantly, it aided organisation:

"... we were able to earlier identify issues whereas the previous MOOC what happened is we went ahead and started to put things in FutureLearn and then it caused a bit of problems when we wanted to introduce new factors and new bits and reorganise it so this really helped with the organisation and the planning." (P06, learning technologist)

During the interview, we asked whether using the framework saved time compared with previous MOOC design processes. Only the learning technologists had previous experience with MOOCs. They felt that the MDMF approach saved time but could not quantify how much time. However, they noted that using the framework resulted in a more efficient process compared with working on previous MOOCs:

"It just felt smoother and it feels like we're not making changes ... late on, whereas previously what we would do is we would just work from the original thoughts but then we go, oh, but what if we move that; whereas with the framework it was quite easy to plan that and you don’t have those changes coming late ..." (P06, technologist)

4.2.2 Learning design

The most beneficial aspect of the framework in terms of the learning design, mentioned by the academics and learning technologists, was that it made them think about the type, sequence and balance of activities:

"And I think one of the important thing is the balance ... so all different types of learning experiences represented in the structure and the learning technologist also explained to us different categories, for example what we could include as interactive activities, what we could include as discussion forum, what we could include in the visual material, and that clarification always helped ... I think it could be quite a different experience if we just list things in a standard Word document and without any specific structure brought into it, so I think it really helps imagining what we have to do and to keep the right balance between the different elements of that structure." (P09a, academic)

Academics and learning technologists both mentioned that the framework helped to construct a more learner-centred design:

"... it [the framework] made sure that the course was varied with the hope that the learners would stay more engaged and therefore learn more from our material." (P01, academic)

"I think as soon as you actually start thinking of the user experience obviously it's going to be more user-centred and you're going to think of their whole experience and actually how they are going to work through the course and which order is the best way content is going to be presented." (P12, learning technologist)

Learning technologists, who had previous experience with developing MOOCs, found it useful that the framework encouraged a focus on design prior to development:

"The difficulty is sometimes I think that people have gone straight to the FutureLearn platform and tried to build their course ... you can actually move content about to try and figure out what the best fit for the course is going to be and also even just to review how it's going to flow, before you actually start putting the effort in to create resource and activities online." (P12, learning technologist)
4.2.3 Visualisation

Academics and learning technologists referred to the visual elements as beneficial in terms of types and sequencing of activity:

"Well one thing that we really, really wanted to do was to actually just put the different activities on the MOOC to see how it looked ... that helps you to picture what it’s going to look like and gives you the confidence to then actually start pulling it together ... into the MOOC online." (P04, academic)

"I like the fact that the different type of activities have different colours, it’s visually I think very immediate... it’s quite easy to see the balance that you have because of the colour coding." (P11, academic)

Both groups of participants mentioned that the framework helped to see the big picture overview and gaps:

"I think it allowed us to clearly see the interactivity and where we were missing certain elements for - you know, get a good broad overview where students were missing a bit more interaction and a bit more of an engaging course." (P06, learning technologist).

4.3 Limitations and suggested enhancements

The limitations and the suggested enhancements are presented together, since they are closely aligned. The main categories under this conjoined theme included process, learning design, and technical aspects.

4.3.1 Process

The main limitation, mentioned by all participants, was that the framework tool did not capture all workshop discussions:

"One limitation of the system, and it may just be how we were using it, there may be a way round this, but it seemed to me that the size of the boxes for each individual step were small, so our tendency was that we tended to just write in three or four words to describe each step." (P09b, academic)

As an enhancement, making space for detailed workshop notes was suggested by several participants. Details of how this feedback has been actioned is explored later in this paper.

"I think it would be good to be able to have on each box some kind of hyperlink to a place where you could have deeper notes that captured the richness of the conversation, rather than be limited to what can fit on the boxes in the framework." (P03, academic)

4.3.2 Learning design

One limitation that a learning technologist mentioned is the danger of the MDMF becoming too prescriptive:

"The danger potentially could be if you try to fit too much into the framework without actually trying to bend the rules of it a bit, where you actually start to become quite prescriptive with your MOOCs instead of thinking about your learners’ experience." (P12, learning technologist)

For this limitation, another learning technologist mentioned simplifying task details as an enhancement:

"... just to keep it more on a visual sort of view to how the course looks and a quick overview of how each week looks on a MOOC rather than getting tied down too much on the acquisitions of skills that are expected on each." (P06, learning technologist)

Only one academic mentioned the visual aspect as a limitation, in the context that it took time to become familiar to the visual layout:

"It took me a while to get used to the layout and as someone used to work primarily with basic lists and tables. I am not a visual person when it comes to planning so this took a while for me to figure out". (P05, academic)
One academic whose MOOC did not align to a current course/programme mentioned that designing a MOOC is more difficult for new course content:

"It's not that we're transferring a course that's already been written to a MOOC programme so we are having to come up with everything right now and therefore when we were sitting with the [learning technologist] we were literally just generating ideas at that moment." (P08, academic)

One academic mentioned difficulties with not understanding specific learning activities:

"I had some uncertainty at the start about what was meant by an article ... I think that over time it became clear to me that an article includes something that we ourselves have written. So, I don't know if there’s a way to just clarify that for new users." (P09b, academic)

Suggestions for enhancement include more guidelines on activity types, and simplifying language or descriptions:

"... to have a short ... like a guideline about a category, for example the written materials, readings, visual materials, before anybody starts to use that tool, to have a kind of guideline document about specific learning documents which could be included in each category." (P09a, academic)

"... the language that’s used or the descriptions of some of the activities or resource types that could be made clearer or even just added to." (P12, learning technologist)

4.3.3 Technical

A range of technical limitations was mentioned by both academics and learning technologists. Firstly, the lack of flexibility with the tool itself:

"Sometimes it wasn’t as flexible. For example, if you’re updating 1.1 you would need to take that out and then update all the other notes that were in there, all the little post-it notes." (P07, learning technologist)

One participant suggested, as an enhancement, to develop the possibility of automatically linking activities to learning types.

One academic mentioned that they had problem with accessing specific weeks, and another noted that it only allowed one author, which is not the case. Therefore, we suggest that this aspect reflects the users' digital literacy. One academic acknowledged this lack of technical expertise:

"I had difficulty accessing one of the MOOC weeks online ... because I'm not that technically minded." (P04, academic)

A possible enhancement could be increased training or adjustments for independent use to help with issues when the learning technology is not there to assist:

"So perhaps there might be a way to make the interface even more, you know, something that people can use on their own... there might be adjustments that can be made there, or maybe just training people into the thinking behind it." (P11, academic)

One learning technologist reported that the tool did not work as well on an iPad as it did on a desktop machine. As an enhancement, another learning technologist with previous experience in MOOCs and learning design suggested using Trello instead:

"... I have sort of used the framework but now we’re using Trello on a couple of MOOCs as a planning tool which seems to kind of work a bit better for people for the ... you know, as a limitation of the software that we’re using. So we’ve moved over to Trello and that seems to be a bit more in favour with the people that I’m working with at the minute but the framework is still there. It’s just in a different tool." (P06, learning technologist)
4.4 Future use

All participants agreed that they would use the framework again when designing a MOOC. Academics had little or no experience with designing previous MOOCs, therefore it was the learning technologists who elaborated further on this topic:

"I think it gives a lot of benefits to the original way of designing MOOCs, which were probably with a Word document or a PowerPoint, or something like that." (P07, learning technologist)

Another learning technologist added:

"I think not just for MOOCs, I think even for any form of course design... it's actually a really good exercise to do because it does get everyone thinking about structure, layout, progression, these, kind of things." (P12, learning technologist)

For the question about whether the MDMF should be standard for designing MOOCs, six academics and all three learning technologists answered yes; however, two academics said no and one was not sure. However, one academic who said no also thought that the MDMF is useful in the initial stage:

"I think it would be useful as a suggested starting point for those who are new to the process but to make it a standard which has to be used I think would be counter-productive." (P05, academic)

One of the learning technologists suggested that it could be used for larger programmes:

"I think in the future not only MOOCs but, because I deal with online learning and online Masters’ programmes, it could be implemented in that particular avenue." (P07, learning technologist)

5. Discussion

The main emerging themes to come out of the thematic analysis relate to learning design, the process of course design, and technical aspects.

5.1 Learning design

The toolkit was mainly used as a mechanism to support users in reflecting on the identification, balance and sequencing of learning activities. Goodyear (2002) denotes the importance of sequencing learning activities to avoid two dangers: firstly, students not knowing what is expected of them, which results in dissatisfaction and unproductivity. Secondly, tutors spending significant time that they cannot spare. The feedback from participants has demonstrated that the framework helps to mitigate these potential pitfalls.

This allowed users to create more learner-centred designs that incorporated active learning opportunities to enhance interactivity and student engagement. This finding is consistent with Murphy (2004, cited by Penna and Stara, 2007) who developed a procedure to facilitate learner-centred design. Briefly, these are: 1) Define target audience; 2) Understanding of user goals; 3) User testing; 4) Small user evaluation; 5) Continued evaluation. The MDMF—together with the FutureLearn platform—facilitates phases 1 and 2 to ensure a learner-centred approach has been followed.

The fact that it took one academic time to get used to the visual layout, or that specific learning activities were not immediately obvious, highlights an acknowledged need for additional guidance. Such guidance has been subsequently produced, to allow users to run the MDMF approach independently. This resource is available at https://www.gla.ac.uk/colleges/socialsciences/staff/learningandteaching/moocdesign/. We also recommend that the MDMF is used in partnership with a local learning technologist who can guide and support the process.

5.2 Process

The toolkit was mainly used in the early MOOC design stages and supported overall project management through regular meetings. It was clear that the workshop facilitator played a critical role in ensuring engagement with the toolkit. This is not surprising; Jisc (2017) describes the role of a learning technologist as “...daily influencers of the learner experience”, while being the “bridge between technology and teaching and...
learning”. They therefore play a critical role not just in knowing how the learning technology works, but also how to use it to its best pedagogical effect. As well as supporting dialogue between the learning technologist and academics, facilitation of the toolkit mediated communication between academic team members, who became more focused on the end goal. This is encouraging when compared to the research of Solomon (2010) who found that managing conflict, decision making and expressing opinions was challenge for collaborative virtual teams.

5.3 Technical issues

Given that the MDMF approach is built upon a third-party online tool, there are inevitably technical challenges to navigate. Some of these related to the limitations of the tool itself, while others were a result of variable digital literacies among academics. The availability of the RealTimeBoard app should help to alleviate issues encountered by iPad users. Nevertheless, we recognise that the tool should be as user-friendly as possible. As academics are increasingly expected to engage in online distance and blended learning, so the need for academic staff development around technology-enhanced learning and teaching (TELT) increases. At the University of Glasgow, this is supported through a number of mechanisms, including credit-bearing academic programmes, informal continuing professional development event, a TELT community of practice, and through the support and encouragement of college and school learning technologists.

5.4 Limitations of the research

We acknowledge that the study did contain a number of limitations as follows. In terms of a potential response bias (Cannell, Miller and Oksenberg, 1981), it is altogether possible that the participants’ responses were influenced by the professional relationship between the first author (JK), also the key learning technologist to have worked closely with all the participants. To try to mediate this, interviews were conducted by the second author (FG), and personal identifiers removed prior to data analysis.

Secondly, this evaluation study was a focused case-study of the use of the MDMF approach at a single institution. To fully evaluate the transferability of the findings, and potential use of the approach, the authors suggest that a wider, cross-institutional study takes place. We would therefore welcome the opportunity to work with other learning technologists in rolling out this learning design approach at other institutions. The Creative Commons licensed resources are available at https://www.gla.ac.uk/colleges/socialsciences/staff/learningandteaching/moocdesign/.

6. Conclusion

This paper presents the outcomes of the implementation and evaluation of an innovative, online approach to designing MOOCs. The MDMF approach surfaces the importance of learning design, particularly in terms of selecting and sequencing different types of learning activities, in an immediately accessible and engaging format that allows the users to create a learner-centred approach to online learning.

The approach has been shown to be effective in supporting the design process, as facilitated by a learning technologist. The design process now introduces efficiencies as a result of a focus on design before development, and increased communication between academics and learning technologists, and across the academic team.

Technical issues arose from the evaluation, relating to the chosen technology itself, as well as the digital literacies of staff. Potential enhancements to address these have been presented. Finally, more cross-institutional work needs to be undertaken to assess the potential for enhancing MOOC learning design at other colleges and universities.

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References


Appendix A: Detailed interview questions

For academic staff:
1. What previous experience do you have of designing a MOOC?
2. Have you used a learning design approach before (for online or face-to-face courses)?
3. What were your overall impressions of using the framework?
4. Can you tell us in detail how you used the framework and how you were supported in using it?
5. What were the benefits?
   a. Specifically, do you feel it brought increased collaboration to staff involved in the design process?
   b. Did you feel that your course was more learner-centred as a result?
   c. Did it save you time compared to designing MOOCs previously? In what ways?
   d. What did you like most about the framework?
6. What were the limitations of the framework?
   a. What did you like least?
   b. What modifications would you suggest?
7. Would you use this framework again?
8. Do you think that the framework be deployed as standard for designing all MOOCs?

For learning technologists?
1. What previous experience do you have of aiding the design process for a MOOC?
   a. How many have you been involved with?
2. Have you used a learning design approach before (for online or face-to-face courses)?
3. What were your first impressions of using the framework?
4. Can you tell us in some detail how you used the framework and how you introduced it to staff and how you supported them using it?
5. What were the benefits?
   a. Specifically, do you feel it brought increased collaboration to staff involved in the design process?
   b. Did you feel that the course was more learner-centred as a result?
   c. Did it save you time compared to designing MOOCs previously? In what ways?
   d. What did you like most about the framework?
6. What were the limitations of the framework?
   a. What did you like least?
   b. What modifications would you suggest?
7. In your role, what did the framework allow you to do that your previous methods didn’t?
8. Would you use this framework again?
9. Would you recommend that the framework be deployed as standard for designing all MOOCs?
The Importance of Dynamic Geometry Computer Software on Learners’ Performance in Geometry

Folake Modupe Adelabu¹, Moses Makgato¹ and Manto Sylvia Ramaligela²
¹Tshwane University of Technology, Pretoria, South Africa
²University of Limpopo, Polokwane, South Africa
foalaadelabu@gmail.com
makgatoM@tut.ac.za
sylvia.ramaligela@ul.ac.za

Abstract: The use of dynamic geometry computer software (DGCS) is important in educational environment, and it is more advantageous for learning mathematics comprehensively. This study examined the importance of dynamic geometry computer software on learners’ performance in geometry. A quasi experimental, non-equivalent control group was used. The instrument used in this study was geometry achievement mathematics test (GMAT) that comprised 15 multiple choices items. The GMAT was administered to 87 grade nine learners in two secondary schools in Tshwane south district, Gauteng Province South Africa. One school was used as experimental group and the second school was used as the control group. Data analysis employed the use of the statistical t-test independent sample. The result of the study shows that using DGCS is important in geometry whereby it improves the performance of learners. In addition, the results show that the software affects the female learners’ mathematics performances more positively than the male learners. Hence, the results of this study showed that there is great potential in using the DGCS (GeoGebra) to teach secondary schools mathematics. The study recommends that the use of technology in teaching and learning of mathematics should be a priority in the schools.

Keywords: Dynamic Geometry Computer Software, GeoGebra, Geometry Mathematics Achievement, Mathematics Performance, Information and Communication Technology

1. Introduction

For quite a number of years now, technology has become part of almost all area of our lives. Recently, Information and Communication Technologies (ICTs) are being integrated into the learning environment as well. In South Africa, National Department of Education (NDoE) and Department of Communication (DoC) came with a strategy on ICT in education which was the foundation of e-Education White Paper that was adopted in 2004. According to the White paper, it was proposed that, every learner in primary and secondary schools sector should be capable of ICT (Isaac, 2007). This indicates that, ICTs should be used assertively and creatively to help individuals to develop the skills and knowledge that are needed to meet the expectations of the 21st Century education and society. In addition, the use of ICT helps achievement of individual personal aims and objectives as well as enabling individuals to participate fully internationally (Department of Education, 2004). In line with the policy, many schools in various provinces in South Africa were equipped with ICT devices such as computers, internet connectivity, tablets and mobile devices to conduct teaching and learning (Farley, Gerard, Sayre and Carter, 2015). This technology integration also provides training for school educators in order to use the equipment and to facilitate teaching and learning in the class through modern technology (Gauteng Department of Education 2016).

In Mathematics classroom, the use of technology helps learners and teachers to perform better calculations, analyse data and enhances the exploration of mathematics concepts, thus resulting in permanent and effective learning in Mathematics (Akgul 2014). Since ICT is significant in educational environments, there is a need to resolve which way of using technology is more advantageous for learning mathematics comprehensively. Integration of technology in mathematics education is mainly done through the use of computers in the learning environment (Akgul 2014). Web-based interactive learning objects, interactive applets, spreadsheets, and graphing programs are some types of computer applications, which are currently being used in mathematics education through computer (Shields and Behrman, 2000).

In South Africa, the integration of technology to teach at both primary and secondary schools has improved learners’ achievement in mathematics and some other subjects (Naidoo and Govender, 2014). Nevertheless, general report on learners’ performance in mathematics has not been encouraging (Spaull, 2013). This has
been a cause of concern to educators, government, parents and the public. Research studies have reported a number of defects in teaching and learning of mathematics (Howie, 2003; Mji and Makgato, 2000). For example, the Trends in International Mathematics and Science Study (TIMSS) 2011 reported that South Africa demonstrated low performances at grade 9 levels for both mathematics and science. School-leaving National Senior Certificate (NSC) matriculation examination poor performance was a cause of concern to the general public (Spaull, 2013). Reports revealed that there is a decrease in proportion of learners taking mathematics and decrease in number of learners passing NSC mathematics (DBE, 2015; 2016).

The research reports presented revealed that there is a critical issue regarding teaching and learning mathematics in South Africa (Mji and Makgato, 2006; Yilmaz, Altun and Olkun, 2010; Dhlamini, 2012; Luneta, 2015; Arbain and Shukor, 2015). Mathematics can be regarded as a challenging subject; also, learning mathematics involves understanding the theories and formulae in order to describe the given concept (Arbain and Shukor 2015).

In the typical classroom of mathematics, the challenges of learners are; difficulties to comprehend and psychosocial factors. The challenges include; negative attitudes, mathematics anxiety, poor study habits, and poor problem-solving behaviour (Department of Basic Education, 2014). For a learner to have difficulties to comprehend a concept of mathematics is a challenge that requires attention. Hence there should be a way of improving learners’ ability to understand and elevate their performances in mathematics. This study therefore investigates the importance of dynamic geometry computer software (technology) on grade nine learners’ performances in geometry.

Research questions
The research questions for this study are as follows:

- Is there a significant difference between learners’ mathematics performance in experimental and control groups after the intervention of dynamic geometry computer software?
- Is there a significant difference between male learners’ mathematics performance in experimental and control groups after the intervention?
- Is there a significant difference between female learners’ mathematics performance in experimental and control groups after the intervention?

2. Review of literature

An essential factor of quality mathematics education is the appropriately use of technology in teaching and learning mathematical concepts (Yanik, 2013). According to Principle and Standards for School Mathematics documents [NCTM], (2000), technology is very crucial in teaching and learning mathematics; this influences learners’ learnings. Use an alternative term Technology, according to Clark-Wilson and Mostert (2016) facilitates mathematics teachers to construct lessons’ resources that include a precise mathematical content and illustration. In addition, it gives a prospect for learners to be propelled to mathematical ideas and perceptions in new ways. In the classroom, technology is used for exploring the mathematics curricula (Clark-Wilson and Mostert, 2016:3). It is essential to teach mathematics concepts with technology which can be the way that will give learners the capability to solve factual problems encounter with conventional method (Tezer and Cumhur, 2017). One of the essential areas of mathematics curriculum that can be explored by technology is geometry.

As far back as 1844 geometry was listed as university entrance requirement in the United State. Since then, geometry has been a stable part of secondary school mathematics curricula (Hollebrands and Stohl Lee, 2011). The reason for including geometry is mainly based on its applicability to the world around us. Geometrical tools have been an important part of learning geometry. These tools have transformed from physical objects, such as a compass and straightedge (ruler), to technological tools such as computer and handheld like graphing calculators and iPad (Hollebrands and Stohl Lee, 2011).

Further, geometry is generally collected with study of abstract idea, such as points, that have no dimension or lines of one dimension that go on without end. These objects can only be imagined in the mind. Geometry is a visual subject and it is difficult to imagine thinking geometrically without sketching a picture or using some variety of visual objects to represent an abstract geometric idea. Learners often have difficulty reasoning about
representation of different geometric objects. Also, representation can sometimes difficult for learners to interpret (Hollebrands and Stohl Lee, 2011).

Geometry textbooks in schools provide representation of figures or shapes only with pencil and paper. Textbook-based illustration may not be comprehensive, because there will be no detail visual description of a complete dynamic process needed for the construction of geometrical concept (Denbel, 2015). Textbook cannot visualize the dynamic nature of geometrical figures on paper. As a result, learners are compelled to mentally look into the possible properties of geometrical objects without an external way to increase understanding of the related concepts (Denbel 2015). Therefore, learners often fail to develop insights into the taught concept (Mehdiyev, 2009; Denbel, 2015). This problem remains persistent in teaching and learning in geometry environment which lacks dynamic feature that may facilitate the justification and validation of definitions, axioms and theorems in a perspective manner (Mehdiyev, 2009).

To supplement the pencil and paper in teaching geometry and to bring motivation on the part of learners, a new environment was proposed by researchers (Laborde, 2001; Flores 2002; Hohenwarter and Jones, 2007). The researchers suggested that the use of technology improves learners’ understanding and therefore recommends dynamic geometry environment for teaching and learning geometry (Ding and Jones 2006). Dynamic geometry environments (DGES) are particular technology tools that have been used in the teaching and learning of geometry to assist learners in moving beyond the specifics of a single drawing to generalisations across figures and shapes (Hollebrands and Stohl Lee, 2011). Dynamic geometry environments (DGES) have been used in mathematics classrooms, mostly in secondary schools and colleges setting, since the late 1980s. Dynamic geometry environments (DGES) provide ways of representing and manipulating geometric objects that are not possible with paper, pencil, compass, and straightedge alone. These various environments allow different opportunities for learners to employ with geometric objects and their procedures. Also, the environments have the potential to help learners develop different understandings of many properties and theorems. In contrast to the conventional environments that can be called paper-pencil environment, DGCS provides learners with potential prospects in terms of making assumptions, testing and exploring theorems and relations (Guven and Kosa, 2008).

In the dynamic environments, learners explore mathematics because the environment provides learners with a sense of control, which means there is no timidity among learners if anyone makes mistake. Also, learners gain confidence in solving mathematical problems; and the use of dynamic geometry computer software is likely to change the attitude of learners to mathematics even when they experience difficulties (Naidoo and Govender, 2014). The understanding of the concept will offer a base from which learners develop insights into the geometry concepts and ideas as well as skillfully apply them in solving problem (Uddin, 2011). Hence, teaching and learning mathematics with dynamic geometry computer software tool will help the learners to understand geometry concepts.

According to Kilic (2010) learning of geometry involves visualisation and constructions of images (shapes and patterns) of geometric concept. Similarly Kutluca (2013) and Özçakir (2013) also agreed that in learning geometry learners should be able to develop some basic skills. These skills comprise of logical thinking abilities, spatial intuition about the universe, comparing and generalising, being careful and patient, reading and comprehending of geometrical concept. Hence the intervention with dynamic geometry computer software will increase learners’ understanding in logical reasoning in mathematical concepts and enhances their performance.

2.1 Dynamic geometry computer software in mathematics

The use of computer software in geometry is becoming widespread gradually in advanced countries like USA, UK, Nepal, India, China, Malaysia, most especially in Turkey. In most of these advanced countries’ schools, mathematics curricula are being supported by the use of dynamic computer software to carry out mathematics instructions (Guven and Kosa, 2008; Akgül, 2014). However, in developing country such as South Africa, technology tools have not been used in teaching geometry. Dynamic Geometry Computer Software (DGCS) focuses on the teaching and learning of Geometry, mainly Euclidean Geometry, and solving the problems with respect to geometry concepts (Doktoroglu, 2013). It also focuses on the relations among points, lines angles, polygons, circles and other geometrical concepts (Sangwin, 2007). The term “dynamic” means to manipulate, resize and to drag the figure to examine the differences. Dynamic geometry computer software (DGCS) are the computer software which allow the users to construct geometry figures or shapes, to measure
the variables of the shapes and determine the properties of them (Akgul, 2014). It allows the users to drag figures through the screen, make geometric constructions, explaining facts about these constructions and test them so that the user will make generalization about the facts. Dynamic geometry computer software includes GeoGebra, Cabri 3D, Geometer’s sketchpad and Cinderella, all offers teachers and learners a useful facilities for using both Computer Algebra System (CAS) and Dynamic Geometry systems (DGS) together (Hohenwarter and Lavicza, 2009; Akgul, 2014).

Naidoo, (2014) claim that the integration of DGCS in learning geometry enhances the construction knowledge, in addition, the communication and dissemination of ideas in the geometry classroom. The interactive learning environments of DGCS support the teaching and learning of abstract geometrical concept in mathematics (Naidoo, 2014). According to Naidoo and Govender (2014) DGCS influenced learners in two ways, which are; learner-centred education and self-regulation. These researchers claim that DGCS make learners think independently, therefore teachers act as facilitators, who only assist learners when encountering problems. Through the use of DGCS, learners apply self-regulation since they work on their own. According to Yaacob, Mohamed and Ariffin (2016) DGCS help learners in mastering the computer technology and improve their skills in geometry. Koparan and Yilmaz (2015) concluded that DGCS contributes more to the prospective teachers in the setting of intersection surfaces (3D objects) than the process in which pencil and paper are used. Therefore, the DGCS has been found to be an effective tool in teaching 3D objects in geometry. DGCS can be expressed as: Cabri geometry, Geometers’ sketchpad, Cinderella and GeoGebra. GeoGebra is particular appropriate DGCS for this study.

2.2 GeoGebra

GeoGebra is interactive computer software that has played a very important role in teaching and learning of geometry in secondary schools. The software can be downloaded by teachers or students or any individual to use at home and explore the idea without an instructor. GeoGebra computer software application can be run without an internet connection when installed on a personal computer, it can run within a web browser as well. GeoGebra provides a platform for high-level of thinking particularly for the teachers while learners engage with the interactive features of the software such as learning from the feedback, seeing patterns, making connections and working with dynamic images (Edwards and Jones, 2006).

GeoGebra is able to work across various platforms, including Windows, Macintosh, Linux and UNIX. The advantage of the software is that it is free software developed for teaching and learning mathematics in primary and secondary even on to the tertiary level. The application software supports an extensive ranging of mathematics from algebra and geometry construction to calculus and 3-D. GeoGebra could be used with technological devices such as interactive smart boards and tablets. The GeoGebra computer software encourages multiple representations (graphs, equations as well as tables). In other words, GeoGebra provides to see graphical, numerical and algebraic representaions of mathematical object on the same screen with the graph been displayed on the graphic view. Therefore, different illustrations of the same object are brought together dynamically and any alteration in one of these illustrations is automatically changed to the other ones. The basic objects in GeoGebra are points, vectors, segments, polygons, straight lines, all conic sections and functions in x and with GeoGebra dynamic constructions can be done like in any other DGCS (Hohenwarter and Fuchs, 2004). The software could be used for flipped classroom and differentiated instruction. It also improves teachers’ professional development in preparing lesson materials that could be used as a collaboration and illustration tools. The software was developed by Hohenwarter and Yves Kreis in 2001 and incorporates multiple mathematics trends into one single, open-source and user-friendly software. Figure 1 shows the displayed graphic view in the GeoGebra window.
Previous research studies have shown that GeoGebra computer software in teaching mathematics contents is more effective than the conventional teaching that is pencil and paper. Some of the studies that have been undertaken in an attempt to understand the effects of the software on learners’ performance and attitude are explored.

Zengin, Furkan and Kutluca (2012) deduced in their research that the used of GeoGebra is more effective on learners’ learning than conventional method in mathematics education. Martinez (2017), conducted a quasi-experiment non-equivalent research study where the null hypothesis was accepted. However, the experimental group post test scores were higher than the control group. The researcher concluded that GeoGebra computer software could have positive effect on learners learning the high school geometry standards, though the researcher suggested more research on this aspect. According to Arbaín and Shukor (2015), teaching and learning mathematics should not be focused purely on the theoretical, but also a diversity of learning approaches that involve the use of teaching materials confirmed to help stimulate learners’ interest in mathematics. Therefore, the conclusion of these researchers is that dynamic geometry computer software has positive impact on the learners’ achievements especially in statistics. Also, learners have positive opinion about the software in terms of enthusiasm, confidence and motivation. A quasi experiment conducted by Zuljadi and Zamri (2017) showed statistically significant differences in procedural and conceptual knowledge of learners who use dynamic geometry computer software (GeoGebra) and learners taught using conventional method in mathematics functions. These researchers claimed that using GeoGebra strengthens and enhance procedural and conceptual knowledge of the learners than conventional method in mathematics functions.

Selvy, Johar and Ansari (2016), concluded that experimental group was in very good category and individual learners are in the excellent category. This means that dynamic geometry computer software (GeoGebra) enhances the understanding of the learners about reflection. The use of the software also motivates and creates interest in the learners to learn mathematics. Adegoke (2016) concluded the non-equivalent pre-post control group design research that incorporating DGCS (GeoGebra) in learning mathematics improves learning outcome and performance of learners. The finding of DiJanić and Trupčević (2017) showed that computer guided discovery learning model by using dynamic geometry computer software interactive applets in mathematics teaching had certain perspectives which resulted in better acquisition of both procedural and conceptual knowledge than does conventional teaching of mathematics.
2.3 Gender differences in using technology for learning mathematics

Considering gender differences in the use of technology (computer) studies indicated that male learners have advantage over female learners in the use of technology (Kay, 2006; 2007; Batol and Aspray 2006). In the ability to use computer, females reported feeling helpless, nervous and uncomfortable around computers. Also, male was rated higher than female in technological skills and ability (Wong and Hanafi, 2007; Houtz and Gupta, 2001; Shashaani and Khalili, 2001). Another study indicated that most females tend to view technology as a tool while males tend to view technology as a toy (Eck, Hale, Ruff, and Tjelmeland, 2002; Bebetsos and Antoniou, 2009). On the contrast, according to Fatemi, Rostamy-Malkhalifeh and Behzadi (2012), the use of software and electronic context in mathematics education has positive efficiency for female learners. The researchers concluded that the feedback was better among female than male learners, however, the use of software and electronic procedure helps both male and female in mathematics. Furthermore, the study of Caliskan and Kesan (2013) revealed that there was no significant difference between geometry achievement and retention levels of learners in experimental and control group after the application of DGCS in terms of gender. The researchers concluded that both conventional method and teaching geometry with DGCS have not produced a difference on male and female learners’ achievement and retention levels. In contrast to this, the study conducted in two schools in Australia by Forgasz, Leder and Vale (2009) indicated that male learners were more likely than female learners to believe that computer software used would improve their mathematical understanding. The researcher also, claimed that, the effects of computer usage in lower grades are more likely to be advantageous to males’ learning mathematics.

3. Research design and methods

In order to address the research questions, a quantitative approach with the use of case study quasi experimental research design was employed. A quasi experimental, non-equivalent control group was used. In the quasi-experimental design, groups are considered non-equivalent as they are not randomly selected. Therefore, non-equivalent groups specifically mean that participant individuality may not be balanced equally among the control and the experiment group (Cohen, Manion, and Morrison, 2007). Non-equivalent groups also means that participants’ experiences differ during the study that is; some receive treatment and some may not receive (Heiman, 1999). The reason for using a quasi-experiment was that it was not possible the researcher to assign the learners randomly into two groups because of differences in the schools. The study was conducted in Tshwane South District Gauteng Province South Africa. Convenient and purposive sampling were used to select the participants of the study. Two schools with regular grade nine learners were conveniently and purposively selected. One of the two schools was used for the experimental group because there was availability of computer laboratory, while the other school was used as the control group because computer laboratory was not available. A total number of 87 regular grade nine learners participated in the study.

The instrument used in this study was Geometry Mathematics Achievement Test (GMAT). The GMAT was used as pre-test and posttest to examine learners’ performance in both experimental and control group. Fifteen (15) items of a standard geometry test was adopted to form the (GMAT) test. The control group was taught geometry (similarity and congruent triangle) by the teacher using conventional method while the experimental group was taught geometry by the researcher through the use of DGCS. Prepared activities on similarity and congruent triangles were given to the learners in the experimental group through the computer software, while the control group used textbook and chalkboard for their activities. The Learners were guided to learn and ensured their understanding on these aspects of geometry. The pre-test (GMAT) was administered to both groups at the beginning of the experiment. The topics were very new to the learners at the commencement of the experiment, though, they might have had the knowledge of such in their lower grades. The GMAT was administered to both experimental and control groups again as posttest to compare learners’ performance. The time allocated for the test was 30 minutes and the study lasted for eight weeks.

Reliability of the instrument was established using Cronbach’s alpha coefficient which was 0.9. The distribution of participants to experimental and control groups is illustrated in table 1 below.
Table 1: Number of learners in the study

<table>
<thead>
<tr>
<th>Group</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>19</td>
<td>18</td>
<td>37</td>
</tr>
<tr>
<td>Control</td>
<td>23</td>
<td>27</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>45</td>
<td>87</td>
</tr>
</tbody>
</table>

Using DGCS (GeoGebra) as intervention in this study, the experimental groups of learners were introduced to the computer set of task within GeoGebra. The section was done for the first and second lesson of the study. The main aim was to orientate the learners to the computer software (GeoGebra); exploring and introducing different menu options as well as familiarising them to the use of the software. Specifically, orientation was on basics icons used within the software for geometry. The major idea of the researcher at this section of the experiment was to let learners experience the features of the software and to create motivation and interest in learners towards the use of the software and mathematics. Dynamic geometry computer software [DGCS] (GeoGebra) was used to create applets representing similar and congruent triangles taught in this research study. Twelve applets were designed to represent the planned similar and congruent triangles by the researcher. The data collected from both groups was analyzed using statistical t-test to find the improvement of learners’ performance.

To analyze the quantitative data collected during the research, statistical t-test for two independent samples was performed. For that purpose, Microsoft Excel 2016 was used to observe whether there is significant difference between the two groups. The significance of the difference between the mean scores of the groups interpreted as p<0.05.

4. Results

Analysis of the pre-test and posttest geometry mathematics achievement test scores were conducted using Microsoft Excel 2016. The pre-test result for both experimental and control group are presented in Table 2.

Table 2: Results of the statistical t-test independent sample on the pre-test of experimental and the control groups

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>T-value</th>
<th>DF</th>
<th>P(2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>37</td>
<td>31.11</td>
<td>8.75</td>
<td>0.788</td>
<td>85</td>
<td>0.433</td>
</tr>
<tr>
<td>Control</td>
<td>50</td>
<td>29.36</td>
<td>10.99</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

T-value significant at p<0.05

The statistical t-test independent samples’ results indicates that there is no significant difference between the experimental group (M = 31.11, SD = 8.75) and control group (M = 29.36, SD = 10.99). The t value (85) = 0.788, p = 0.433 > 0.05. This result answered the first research question whether there is a significant difference between mathematics performance of learners in experimental and control groups before the intervention. The indication means both the experimental and control group were in the same level of mathematics performance before the commencement of the experiment.

To answer the first question, is there a significant difference between learners’ mathematical performance of experimental and control groups after the intervention of dynamic geometry computer software? Table 3 shows the computed results of statistical t-test independent sample on the post-test of both groups.

Table 3: Results of the statistical t-test independent sample on the post test of experimental and control groups

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>T-value</th>
<th>DF</th>
<th>P(2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>37</td>
<td>41.81</td>
<td>9.27</td>
<td>2.970</td>
<td>85</td>
<td>0.004</td>
</tr>
<tr>
<td>Control</td>
<td>50</td>
<td>34.88</td>
<td>11.54</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

T-value significant at p < 0.05
The statistical t-test independent samples’ result indicates that there is statistically significant difference between the post-test mean scores of the experimental group (M = 41.81, SD = 9.27) and the control group (M = 34.88, SD = 11.54). The t value (85) = 2.970, p = 0.004 < 0.05. Therefore, there is a statistically significant difference between the two groups with regards to their performance in geometry after using DGCS to teach the experimental group. This implies that learners who use DGCS achieved higher scores than the learners taught by the conventional method (control). Furthermore, the mean score of the experimental group is substantially higher than that of the learners from the control group.

Table 4 shows the result of statistical t-test independent sample on the posttest of male learners score in experimental and control groups to answer the third questions whether there is a significant difference in their performance after the intervention.

**Table 4: Results of the statistical t-test independent sample on the posttest of male learners’ scores in experimental and control groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>T-value</th>
<th>DF</th>
<th>P(2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>19</td>
<td>40.05</td>
<td>8.38</td>
<td>1.235</td>
<td>40</td>
<td>0.224</td>
</tr>
<tr>
<td>Control</td>
<td>23</td>
<td>36.17</td>
<td>10.98</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

T-value significant at p < 0.05

The statistical t-test independent samples’ result shows there is no significant difference between the posttest mean scores of the male of the experimental group (M = 40.05, SD = 8.38) and the control group (M = 36.17, SD = 10.98). The t value (40) = 1.235, p = 0.224 > 0.05. The indication of this result means that the dynamic geometry computer software does not have effect on the male learners’ mathematics performance in the experimental group. Even though, the mean score in experimental group (40.05) is higher than the mean scores in control group (36.17) but the level of significant is greater than 0.05, hence there is no statistically significant difference between both groups on male learners.

Table 5 shows the result of the statistical t-test independent sample on the posttest of female learners score in experimental and control groups to answer the fourth questions whether there is a significant difference in their performance after the intervention.

**Table 5: Results of the statistical t-test independent sample on the posttest of female learners’ scores in experimental and control groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>T-value</th>
<th>DF</th>
<th>P(2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>18</td>
<td>43.67</td>
<td>9.79</td>
<td>2.862</td>
<td>43</td>
<td>0.0006</td>
</tr>
<tr>
<td>Control</td>
<td>27</td>
<td>33.78</td>
<td>11.89</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

T-value significant at p < 0.05

The statistical t-test independent samples’ result shows there is no significant difference between the posttest mean scores of the female of the experimental group (M = 43.67, SD = 9.79) and the control group (M = 33.78, SD = 11.89). The t value (43) = 2.862, p = 0.006 < 0.05. The result indicates that dynamic geometry computer software has effect on the female learners’ mathematics performance of the experimental group. This indicates that female learners in the intervention group (experimental) taught through dynamic geometry computer software achieve higher scores than those female learners in the control group who were taught by the teacher.

**5. Discussion**

In this part of the study, findings collected through the analysis of the data gathered in the direction of research questions were explained and interpreted. Before the intervention the results revealed that there was no significant difference between the pre-test of the experimental and the control groups. The indication means that the two groups were equivalent in term of the mathematics performance as the statistical t-test result shown [t (85) = 0.788, p = 0.433 > 0.05]. Therefore, the grade 9 learners from the two secondary schools can be compared while assessing the teaching processes that apply using DGCS to learn mathematics and learning through the conventional method. However, after the intervention, the results revealed that there was a statistical significant difference between the mean scores of experimental and control groups. The
indication of the result means DGCS increases the performance of the experimental group learners in the subject of similarity and congruent triangle as the statistical result shown \[ t (85) = 2.970, p = 0.004 < 0.05 \]. This also indicates that DGCS increases their understanding in the subject area. The results obtained in this study are in agreement with the studies of Zengin et al (2012), Kesan and Caliskan (2013), Arbain and Shukor (2015), Adegoke (2016), Zulnadi and Zamri (2017). In these studies it was reported that learners exhibited good motivation, better understanding and higher performance when learning mathematics with dynamic computer software than conventional method.

It was also found that, there was no significant difference between male learners’ mathematics performance of both the experimental and the control group \[ t (40) = 1.235, p = 0.224 > 0.05 \]. The indication of this result means, both male learners of the experimental and the control groups were equivalent even, after the use of DGCS (GeoGebra). This indicates that the DGCS did not cause any significant difference between the mathematics performances of male learners. On the other hand, it was also found that there was statistical significant difference between the female learners’ mathematics performance of the experimental and control groups \[ t (43) = 2.862, p = 0.006 < 0.05 \]. This means DGCS (GeoGebra) increases female learners’ mathematics performance in similarity and congruent triangles. The indication of the two results is that DGCS increases the understanding of female learners more than the male learners.

In this study the use of DGCS (GeoGebra) makes female learners’ performance better in mathematics than the male learners. These findings are in contrast with other research findings which proved that there were no significant differences between mathematics performance of learners in term of gender within the same group using dynamic geometry computer software (Kesan and Caliskan 2013; Yildiz and Aktas 2015). However, there were limited research study shown result in term of gender comparing experimental and control groups. In this study when comparing the male and female learners of both experimental and control groups, DGCS affected the female learners of the experimental group in a positive way than female learners in the control group.

6. Conclusion

Mathematics can be regarded as a challenging subject. Mathematics especially geometry involves understanding the theories and formulae in order to describe the given concept. The use of technology (DGCS) provides extensive opportunities for facilitating, supporting and enriching mathematics learning in schools. The study explored how Dynamic Geometry Computer Software (DGCS) is important in mathematics. In particular, the use of GeoGebra as an intervention during the study facilitated the understanding and improved the performance of the learners in the experimental group. Learners appeared to be satisfied with dragging the figures but sticking to the basic computer software tools. Hence, the use of DGCS has more advantage on learners’ performance in mathematics than using conventional method (paper and pencil).

The use of the DGCS motivates learners to learn mathematics without anxiety, gives them enthusiasm to learn without any negative attitude towards mathematics and solves the problem of difficulty in understanding geometry concepts. Learners in the experimental group had advantages over the control group because the software enabled them to check the accuracy of the method used to determine their work on the computer screen which was a great success this could foster the retention level of learners. In addition, learners who used DGCS could revisit the activity several times while the control group could not be able to do so. In the control group teaching was limited to few examples, because drawing geometry shapes on the chalkboard spent time and space. Furthermore, not all teachers have the skill to illustrate good and excellence geometry shapes on the chalkboard. Therefore, with DGCS drawing and outlines are well-ordered and precise. DGCS allowed learners in the experimental group instantaneous exploration opportunities. The correct representation of objects and measurement brought a union and lead to understanding that might be different from a static paper – pencil environment (Sinclair, 2006).

The importance of using DGCS in learning geometry is that the software helped and improved learners understanding and performances. Hence, making DGCS available in the schools will make it more reasonable to use. The results of this study showed that there is great potential in using the DGCS (GeoGebra) to teach secondary schools mathematics in South Africa. Therefore, this study recommends that the use of technology
in teaching and learning of mathematics should be a priority in the schools. Furthermore, to enable teachers to work with DGCS successfully, the study suggests that basic skills and knowledge of computer use are essential. Mathematics teachers should be trained beyond basic skills of computer use because extra support and training are required to sufficiently and confidently use DGCS. Mathematics teachers should also make use of the software as often as possible so that learners are encouraged to go beyond memorizing formulae and instead grasp the concepts. As a result learners can gain more understanding and improve their performances in mathematics. As a final point, the finding in this study served as the first step, therefore, to comprehend the effect of DGCS more on learners, there is need for further studies with bigger data set, which could accommodate more than 500 learners with duration of two years or more. In this regard, full standard geometry test could be used in at least 10 schools for further studies.

References


Bebetos, E and Antoniou, P. 2009 Gender differences on attitudes, computer use and physical activity among Greek university students. The Turkish Online Journal of Educational Technology – TOJET April 2009 ISSN: 1303-6521 volume 8 Issue 2


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Editorial for EJEL Volume 17 Issue 1

This issue of the EJEL leads through three different continents and demonstrates the diversity of e-Learning with its various target groups; formal and informal learning contexts, as well as diverse learning tools ranging from mobile apps to Massive Open Online Courses. The various research methods used, from focus group discussions and questionnaires to the evaluation of automatically collected learning analytics data, also provide a very interesting and multi-layered picture of the research methodology applied in the field of e-Learning. All in all, the current issue of the EJEL mirrors the constant progress of e-learning through improved information and communication technologies (ICT) and, in particular, improved concepts for employing the technologies effectively.

The first study once again makes evident that e-Learning is not a matter of course, but requires careful preparation. From the view of Indonesian school principals, the study entitled “An Explanatory Sequential Study on Indonesian Principals’ Perceptions on ICT Integration Barriers” explores the obstacles to the use of ICT in secondary schools in developing countries. In a sequential study approach, a questionnaire has been developed. This questionnaire then has been answered by 250 secondary school principals all over Indonesia. Based on the results, focus group discussions have been conducted. Among the obstacles reported by the authors Lantip Diat Prasojo, Akhmad Habibi, Mohd Faiz Mohd Yaakob, Amirul Mukminin, Septu Haswindy and Muhammad Sofwan are some phenomena well-known from other regional contexts too, such as teachers’ knowledge of ICT, scarce funding for ICT and incongruity with traditional teaching styles. Based on these findings, recommendations for improving the situation are given. Whether and to what extent the proposed recommendations differ from the established ones is something the inclined readers may learn for themselves when reading the article.

The subsequent study stems from Hongkong, China. Dennis Foung and Jula Chen analyze their article “A Learning Analytics Approach to the Evaluation of an Online Learning Package in a Hong Kong University” the online behavioral data of an impressive number of more than 7000 students enrolled in an English language course. Data about assessment component scores, online activity completion rates, and online behavioural patterns has been aggregated and can now assist blended learning course designers to adapt the courses to representative student behaviour patterns. Further, the possibility of predicting the probability of successful completion of a course also opens up new opportunities for interventions. The resulting attempts at activation of students may increase the rate of successful completion, which would be a definite asset of e-learning.

In the next study, which takes us to the capital of South Korea, Seoul, students have been again directly surveyed. Eva Maria Luef, Bethel Ghebru and Lynn Ilon examine the role that the smartphone plays in language learning for Korean students considered to be highly technical. In their article “Language Proficiency and Smartphone-aided Second Language Learning: A look at English, German, Swahili, Hausa and Zulu” the authors investigate both informal and formal learning settings. The language proficiency in general as well as the English language skills in particular are understood as determinants for the use of language learning apps. With the results of the study, potential usage scenarios of mobile and ubiquitously available learning apps are being defined a step further.

Back in Europe we arrive in Scotland with the article “Evaluation of a MOOC Design Mapping Framework (MDMF): Experiences of Academics and Learning Technologists”. John Kerr, Vicki H.M. Dale and Fanni Gyrkko have interviewed experts about their experiences with the design guidelines for Massive Open Online Courses (MOOC) used at the University of Glasgow. As elements of the design process for MOOCs to be further analysed, the study identifies, among others, the role of learning technologists as moderators of the design process, the implications of technological challenges and the level of digital competence of users. These are further perspectives for the design and application of MOOCs that are aimed at increasing the efficiency and effectiveness of MOOCs.

This issue of the EJEL ends in South Africa with a study on mathematical software conducted among secondary school students. Folake Modupe Adelabu, Moses Makgato and Manto Sylvia Ramaligela research the application of the dynamic geometric environment GeoGebra in the classroom. In their article titled “The Importance of Dynamic Geometry Computer Software on Learners’ Performance in Geometry” they report
their promising findings, based on an experimental group and a control group at two distinct schools with a total of 87 students. The study comes to the clear recommendation that the use of a dynamic geometric environment improves students' learning success. Here again the loop to the first article could close: such software can certainly be of assistance for learning if its implementation is not prevented by barriers to the use of ICT.

Journal Editors
Rikke Ørngreen and Heinrich Söbke