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Linking Online Learning Readiness to the Use of Online Learning Tools: The Case of Postgraduate Engineering Students

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BACKGROUND
It has been argued that the development of online learning adopted by Australian tertiary programs has progressed without the proper guidance of a pedagogical model, and this has led to growing student dissatisfaction. Given this concern, it is important to understand which qualities of students are critical for their achievement and satisfaction in an online learning environment, and whether these qualities will likely lead to students' success in online learning. In response to this, a number of online learning readiness assessment frameworks have been proposed by education researchers. However, the relationship between such readiness and online learning outcomes has not been well established.

PURPOSE
The objectives of this research are to assess the online learning readiness (OLR) of a sample group of postgraduate engineering students and to determine whether there is any association between the level of readiness and the extent to which the students use online learning tools.

DESIGN/METHOD
The research employed a questionnaire survey targeting a group of postgraduate students undertaking a project management course at Griffith University. In total, there were 52 students enrolled in this course, representing the sampling frame used in this research. A questionnaire was developed to assess the levels of OLR of the sampled students as well as the extent to which they use each of the four main online learning features, including online learning materials, lecture recordings, online discussion board and online review questions/quizzes. Cluster analysis was employed to group the respondents with similar profile across the OLR variables. The actual use of online learning tools from each cluster was then examined and compared.

RESULTS
Results from the analysis of 30 valid responses indicated that the sampled students could be classified into three main groups: (1) *Developed OLR*; (2) *Less-developed OLR*; and (3) *Developing OLR*. The differences between these groups could be illustrated based on the four OLR factors: *Technical Skills*, *Computer Self-Efficacy*, *Learning Preferences* and *Attitudes towards Computers*. Overall, students in the *Developed OLR* group are the most extensive users of online learning tools whereas those from the *Developing OLR* group are the least extensive users. In particular, the *Developing OLR* students used much less the discussion board and online quizzes than the other two groups. It was also found that students in the *Developed OLR* group used the discussion board and online quizzes as much as those in the *Less-developed OLR* group.

CONCLUSIONS
Overall, the students had different levels of OLR and can be clustered into three main groups: Developed, Less-developed and Developing OLR. The differences between these clusters were mainly influenced by the students' learning preferences and technical skills. Comparing the use of online learning tools among these three groups, the results suggested that the higher level of OLR can be associated with the more extensive use of online learning tools. It was also found that learning preferences seems to play a major role in influencing the extent to which students use online learning tools. In addition, lacking of technical skills seems to have a negative impact on certain types of online learning tools, in this case online discussion board and online quizzes.

KEYWORDS
Online learning, readiness, postgraduate, engineering, Blackboard

Background and Aims

It is well documented in the literature that online learning has become a popular form of educational instruction within the Australian tertiary programs during the past 10 years (Pillay et al., 2007). In particular for postgraduate education, online learning provides a more flexible mode of study for students who are working in the industry and cannot generally afford to take time off to attend regular classes. From a university's perspective, online programs are more likely to attract domestic students currently in the industry sector who are seeking professional development through undertaking a postgraduate degree program. These programs are also perceived to be more cost effective as they can accommodate a large number of students without having to involve as many teaching and support staff as those required in the typical face-to-face programs.

While online learning has become more commonplace in higher education, it has been argued by some researchers (e.g. Alonso et al., 2005 and Summers et al., 2005) that this form of study has progressed without the proper guidance of a pedagogical model. This has led to growing student dissatisfaction, which in turn affects attrition rates. Given this concern, it is important for the program convenors/curriculum developers to understand which qualities of students are critical for their achievement and satisfaction in an online learning environment, and whether these qualities will likely lead to students' engagement and success in online learning.

In response to the above issue, researchers have proposed and tested a number of frameworks that can be used to diagnose a student's level of online learning readiness (OLR). For example, Smith et al. (2003) conducted an exploratory factor analysis (EFA) on the Readiness for Online Learning questionnaire developed by McVay (2001) using a sample of undergraduate students from the US and Australia. The analysis results suggested two underlying factors of OLR: Comfort with E-learning and Self-Management of Learning. These factors were consistent with the subsequent EFA conducted by Smith (2005) using a sample of Australian undergraduate university students. Watkins et al. (2004) also developed a scale for assessing readiness for E-Learning, which was tested (using EFA) based on a sample of enlisted personnel of the US Coast Guard. The authors identified six underlying factors, including Technology Access, Online Skills and Relationships, Motivation, Online Audio/Video, Internet Discussions and Importance to Your Success.

By synthesising several survey instruments, including those constructed by Smith et al. (2003) and Watkins et al. (2004) mentioned above, Pillay et al. (2007) developed their version of OLR scale, namely the Tertiary Student's Readiness for Online Learning survey (TSROL). This instrument was validated using confirmatory factor analysis (CFA) on a sample of 254 undergraduate and postgraduate students in education courses at a large Australian university. The scale consists of four factors: Technical Skills; Computer Self-Efficacy; Learning Preferences; and Attitudes towards Computers.

Despite the development of the above scales to assess OLR, research that examines whether such readiness will lead to specific online learning outcomes has been limited. In recognition of this, the aims of this research are to assess the online learning readiness (OLR) of a sampled group of postgraduate engineering students and to determine whether there is any association between the levels of readiness and the extent to which the students use online learning tools. It should be noted that the extent to which the students use online learning tools was considered as an indicator of student engagement in an online learning environment. Student engagement has been found to be positively linked with desirable learning outcomes (Carini et al., 2006).

Method

Sample and data collection

The research employed a questionnaire survey targeting a group of postgraduate students undertaking a project management course at the School of Engineering, Griffith University. This particular course is offered in a face-to-face mode, with the course convenor making use of a number of online tools available on the *Blackboard 8* platform to aid students' learning. It should be noted all learning materials were only available online with (non-compulsory) in-class lectures recorded and uploaded to the course website. Online quizzes were provided but completing them was not compulsory. In total, 52 students were enrolled in this course; they represented the sampling frame for this research.

A questionnaire was developed to assess the levels of OLR of the sampled students as well as the extent to which they used each of the four main online learning features, including online learning materials, lecture recordings, online discussion board and online review questions/quizzes. The questionnaire consisted of three main parts. The first part, the *OLR* scale (see Table 1), was focused on evaluating the students' online learning readiness. This part consisted of 18 Likert-type questions (1=Strongly disagree, 5=Strongly agree) adopted from the TSROL survey instrument developed by Pillay et al. (2007). It should be noted that this survey instrument was adopted because it is a synthesis of other similar instruments and has been validated using CFA, which is a stricter approach for establishing measurement validity of a survey instrument compared to the EFA. In addition, it was suitable for the context of this study as its validation was based on a sample of tertiary students in an Australian university. The second part of the questionnaire, the *Actual Use* scale (see Table 2), was aimed to measure the extent to which the students utilised the four main *Blackboard* features (tools) on the course website (three questions for each tool): *online lecture materials*; *lecture recordings*; *online review questions or quizzes*; and *discussion board*. This scale consisted of questions developed by the authors of this paper as well as those adapted from Ngai et al. (2007). It should be noted that this scale was self-report as was used because the anonymity of respondents made it impossible to match the actual frequency of use of each student. In management and organisation psychology research, a self-report or subjective measure is considered acceptable when there is a lack of objective measure (Podsakoff and Organ, 1986; Wall et al., 2004). The last part of the questionnaire enquired about the background information of the students. The survey was administered during the beginning of one of the lectures. The students were advised that the participation in the survey was voluntary and the survey was anonymous. Once the students completed the questionnaire, they were asked to return it to the tutor at the end of the class (the tutor was not involved in the research). Prior to the survey, ethics clearance was obtained from the University.

Analysis approach

In order to assess the OLR levels of the sample, descriptive statistical analysis and cluster analysis were conducted using SPSS 19.0 to group the respondents with similar responses across the 18 OLR variables. According to Hair et al. (2006), cluster analysis is an exploratory data analysis tool that aims to categorise cases into groups or clusters so that each case is very similar to others within its cluster. Two major stages of cluster analysis application were carried out in this study: partitioning and interpretation. The partitioning stage is the process of determining the number of clusters that may be developed, whereas the interpretation stage is the process of understanding the characteristics of each cluster and developing a name or label that appropriately defines its nature (Hair et al., 2006). Following Hair et al.'s (2006) recommendation, hierarchical and non-hierarchical cluster analysis procedures were carried out sequentially to identify and produce the major clusters that existed among the sampled group of students based on the 18 OLR variables. The hierarchical procedure was employed to examine the number of clusters that should be

formed, and then the non-hierarchical method was applied to produce the actual clusters that contain the details of the associated cluster members. Following this, the extent to which the students used the four online learning tools was aggregated for each of the identified clusters. The aggregated scores of all clusters were then compared to examine whether there was any association between different levels of OLR and the use of the online tools.

Results

The sample

Out of the 52 students, 32 sets of questionnaire were completed and returned. Two sets of incomplete questionnaire were deemed unsuitable hence removed from the dataset. In total, 30 responses were included in the analysis, representing 58% effective response rate. The snapshot of the demographical information of the sampled students is as follows:

- 80% were male;
- 70% were 20 to 30 years old;
- 50% had done four or more courses that use the four online learning tools;
- 87% were International students; and
- 57% were in their first semester.

Descriptive statistics

Descriptive statistical analysis was firstly conducted on variables from both the *OLR* and the *Actual Use* scales. The mean and standard deviation values of all the variables for both of the scales are presented in Tables 1 and 2. Both scales were found to have high levels of internal consistency, having the Cronbach's Alpha values of 0.900 and 0.802, respectively.

According to Tables 1 and 2, it can be seen that about half of the variables in both of the scales have standard deviation values greater than or close to 1.0, which is equivalent to a difference in one response category. Therefore, the variables' mean values were not appropriate to represent the entire sample, and using them in the analysis could yield inaccurate results. Given this, cluster analysis was proposed to pre-process the data such that individual responses could be cluster into several groups that share the similar scores.

Table 1: Means and standard deviations of the *OLR* variables (n=30)

Variables		Mean	S. D.
Technical skills			
A1	I know how to install software to support my learning using computers	4.03	1.033
A2	I feel at ease when working with computers	4.07	0.980
A3	I can troubleshoot most problems associated with using a computer	3.67	0.994
A4	I have extensive experience using computers	3.90	1.062
A5	I am good at using presentation packages, e.g. PowerPoint	3.97	0.890
A6	I am good at using spreadsheets, e.g. Excel	3.57	1.194
A7	I am able to set up and manage file directories	3.90	1.094
Computer self-efficacy			
A8	I know how to send and receive email messages	4.77	0.430
A9	I feel confident in using computers to connect to the Internet	4.60	0.563
A10	I can use various search engines to research material	4.23	0.817
A11	I feel confident about using basic computer tools such as word processor, spreadsheet and PowerPoint	4.13	0.681
Learning preferences			

A12	I would rather listen to a lecture than read the material from a computer screen (Reverse item)	2.40	1.037
A13	I would rather find out information using a computer than from a teacher or lecturer	2.97	1.033
A14	I can't learn using only computers; I need the teacher–student contact (Reverse item)	1.93	1.081
Attitudes towards computers			
A15	I like using computers for research	4.33	0.711
A16	I like to communicate with others using email to support my learning	4.03	0.765
A17	I spend a lot of time on the Internet	3.97	0.890
A18	I enjoy working on tasks on a computer that I can do by following directions	3.97	0.850

Table 2: Means and standard deviations of the *Actual Use* variables (n=30)

	Variables	Mean	S. D.
B1.1	How often would you say you use ***online lecture materials*** to assist your learning? (1=Never; 5=Always)	3.90	0.995
B1.2	Comparing with your peers, how would you rate your frequency of the use of ***online lecture materials***? (1=Much less; 5=Much more)	3.20	0.664
B1.3	How would you describe yourself as a user of ***online lecture materials***? (1=Non user; 5=Heavy user)	3.57	0.898
B2.1	How often would you say you use ***lecture recordings*** to assist your learning?	2.90	0.960
B2.2	Comparing with your peers, how would you rate your frequency of use of ***lecture recordings***?	2.73	0.868
B2.3	How would you describe yourself as a user of ***lecture recordings***?	2.80	1.031
B3.1	How often would you say you use the ***discussion board*** to assist your learning?	2.43	0.728
B3.2	Comparing with your peers, how would you rate your frequency of use of the ***discussion board***?	2.53	0.937
B3.3	How would you describe yourself as a user of the ***discussion board***?	2.43	0.679
B4.1	How often would you say you use ***online quizzes*** to assist your learning?	3.10	0.995
B4.2	Comparing with your peers, how would you rate your frequency of use of the ***online quizzes***?	2.90	0.845
B4.3	How would you describe yourself as a user of ***online quizzes***?	3.03	0.999

OLR clusters

Cluster analysis was conducted using the entire dataset based on the 18 OLR variables. Results from the analysis indicated that the sampled students could be classified into three main clusters. In order to better understand the specific nature of each cluster, all the OLR variables were aggregated separately for each cluster to represent the four underlying factors of OLR, i.e. Technical Skills (*Tech Skill*), Computer Self-efficacy (*Comp SE*), Learning Preferences (*Learn Pref*), and Attitudes towards Computers (*Comp Att*). The profiles of all the three clusters based on the four OLR factors are presented in Table 3 as well as illustrated in Figure 1. The type of chart illustrated in Figure 1 is typically used in presenting cluster profiles (see Yeung, et al. 2001).

Table 3: Breakdown of cluster profiles

Cluster Number	n	Tech Skill		Comp SE		Learn Pref		Comp Att	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
Cluster 1	11	4.58	5.00-3.57	4.84	5.00-4.00	3.12	4.00-2.33	4.45	5.00-3.00
Cluster 2	14	3.85	4.29-3.14	4.27	4.75-3.75	1.98	2.67-1.00	3.98	4.75-3.25
Cluster 3	5	2.37	2.86-1.75	4.00	4.75-3.50	2.20	2.33-1.67	3.50	4.00-2.50

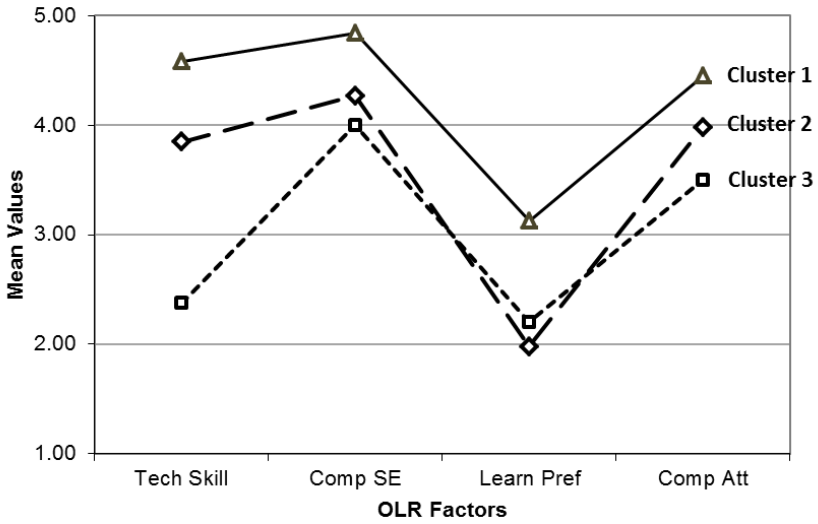

Figure 1: Cluster profile plot

Examining the overall differences between the three clusters, it can be seen that the major differences are mainly attributable to the "Technical Skills" and the "Learning Preferences" factors. The first cluster consisted of students who are moderately self-directed, independent learners and are highly capable of using online learning related technologies, hence labelled the "*Developed OLR*" cluster. The second cluster consisted of students who prefer face-to-face learning but are generally comfortable with, and capable of, using online learning related technologies, hence labelled the "*Less-Developed OLR*" cluster. Finally, the last cluster consisted of students who prefer face-to-face learning; they are less capable in using online learning technologies, but have no resistance toward them. Therefore, the last cluster was labelled the "*Developing OLR*" cluster. In addition, it can be observed that the overall levels of Learning Preferences range from low to moderate, indicating that this sample group of students did not have much tendency towards online learning approach – they still largely preferred a face-to-face learning environment.

Clusters comparison

In order to examine the relationship between the OLR levels and the online learning tools usage, comparative analysis was conducted between the three clusters identified above based on the aggregated scores of all the four OLR factors (calculated using the data from the second part of the questionnaire – the *Actual Use* scale): online lecture materials (B1.1-1.3), lecture recordings (B2.1-2.3), discussion board (B3.1-3.3) and online quizzes (B4.1-4.3). The radar chart in Figure 2 compares the extent to which each cluster used each of the four online tools.

According to Figure 2, lecture recordings and online discussion board seem to be the tools that were much less utilised compared to the other two. The differences in the use of online learning tools among the three clusters can be seen in the online materials, discussion board and online quizzes while this is not the case for the use of lecture recordings. Students in the *Developed OLR* cluster are the most extensive users of online learning tools whereas those from the *Developing OLR cluster*, on the other hand, are the least extensive users. In

particular, the *Developing OLR* students used much less the discussion board and online quizzes than the other two groups. It was also found that students in the *Developed OLR* group used as much the discussion board and online quizzes as those in the *Less-developed OLR* group.

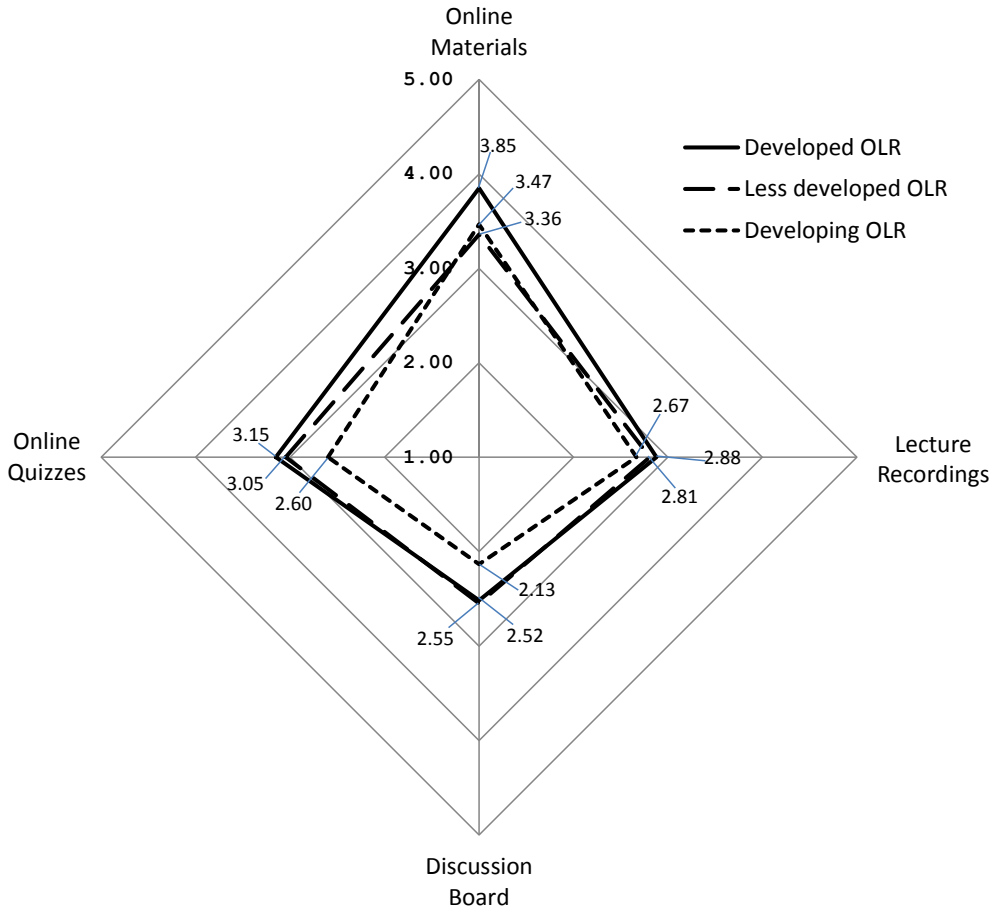

Figure 2: Cluster comparison

Discussion and Conclusion

Overall, the results indicated that students had different levels of OLR and could be clustered into three main groups: *Developed, Less-developed and Developing OLR*. The cluster profiles also indicated that the sampled students in general had good levels of computer self-efficacy and attitudes towards computers. What influenced the differences in the OLR and hence the segregation between the three identified clusters was the students' learning preferences and technical skills. Smith (2005) highlights that a learner's technical skills on computer usage and site navigation as well as willingness to be self-directed and self-manage the learning are the two critical components of readiness for online learning.

In terms of the extent to which the students used the four online learning tools, it was found that overall the lecture recordings and online discussion board were particularly less utilised than the online quizzes and online materials. This may be explained by the fact that because this group of students overall had predominant preferences towards face-to-face learning environment and the lectures and discussions were already carried out in the normal lectures, they were less incline to use such learning tools. This finding can be reinforced by Valenta et al. (2001) who determined that a highly independent learning style (i.e. self-directed) is a predictor of successful technology-mediated distance learning education.

Comparing the use of online learning tools among the three clusters, it was found that the students within the *Developed OLR* cluster were the most extensive users of online learning

tools, whereas those from the *Developing OLR* cluster were the least extensive users. This finding indicates that there is an association between the OLR and online learning tools usage. This supports that the OLR scale adopted from Pillay et al. (2007) could be used to assess online learning readiness of students prior to course commencement or administered to identify specific areas where students require additional support.

Further examination into the comparative results also showed that the students from the *Developed OLR* cluster used the discussion board and online quizzes as much as those from the *Less-developed OLR* cluster, compared to the *Developing OLR* cluster. Investigating the profiles of these two clusters, it was found that their levels of the technical skills were much higher than the *Developing OLR* cluster. In the Blackboard 8 platform, using the two online learning tools could be rather complicated and difficult for some users, particularly those who have less computer skills. Therefore, having equally higher technical skills, the students from both the *Developed* and *Less-developed OLR* clusters tended to be able to use more of these tools than those from the *Developing OLR* cluster who had much lower level of technical skills. This finding is consistent with Pillay et al.'s (2007) argument that students' technical skills influence their levels of engagement with technology – students who have low level of technical skills will most likely avoid engaging in the online learning environment as they tend to experience the difficulty in accessing or navigating online contents. Dray et al. (2011) assert that to be able to characterise prepared and successful online students, the students' engagement with ICT must be considered rather than simply the access to technology.

In summary, the results from the comparison of the use of online learning tools among the three student clusters suggested that the higher level of OLR can be associated with the more extensive use of online learning tools. It was also found that learning preference toward online learning seemed to play a major role in influencing the extent to which students utilised online learning tools. In addition, the lack of technical skills seemed to have a negative impact on the use of certain types of online learning tools that require higher levels of technical skills to operate. In this case, such tools include online discussion board and online quizzes.

Implications

The findings from this study provide a number of implications for program convenors or curriculum developers who are planning to develop an online postgraduate program in Engineering. Firstly, it should be expected that the students will have a different levels of readiness for online learning and this could have an impact on their experience and eventually success in the program. In order to capture such differences, online readiness assessment for the students should be administered earlier prior to their enrolment into the program. Secondly, strategies should be in place to support the students whose preference is predominantly on face-to-face learning. This may include the use of assessment tasks that are designed to encourage active participation through such existing tool as the discussion board. According to Smith (2005), creating an atmosphere that encourage and facilitate collaborative learning is central to the success of an online course. Thirdly, a range of intensive workshops could be offered to those students from the Developing OLR cluster. These workshops should mainly focus on how to use online learning tool as well as strategies for online learning success. Online resource toolkits based on such strategies should also be developed and made available for readily referencing. Lastly, and perhaps most importantly, training should be provided for the course convenors on how to effectively design and deliver online courses. This is particularly important as a pedagogical soundness is as much fundamental to effective online learning and teaching as that of a typical classroom environment.

Limitations and Future Work

This project has a number of limitations which are listed below along with the associated recommendations for future research.

- The sample size was relatively small (n=30). Future research should attempt to include a larger sample size in the analysis. This may reveal additional cluster(s) with a unique OLR profile, and would help to extend the findings of the current research.
- The quality of the online learning tools was not investigated. Future research should consider incorporating such theory as the Technology Acceptance Model (TAM), which may provide a better explanation to the existing findings.
- Learning outcomes were not addressed. Future research should consider examining the relationship between the use of online learning tools and actual learning outcomes of the students.

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