What is Motivating Engineering Students to use 1:1 Mobile Devices for Learning?

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CONTEXT
Engineering education is embarking on a new journey, where curriculum designers are needing evidence based research to understand how the use of 1:1 mobile devices can influence student perceptions of self-directed learning, to improve curriculum engagement and to measurable assessment outcomes. Using student perceptions of learning motivation and learning intervention theory, higher order thinking skills can be encouraged in problem-based learning. Understanding what is motivating students to learn when and using 1:1 mobile devices will help curriculum designers and facilitators to engage students.

PURPOSE
This paper will explore survey results of a recent study, revealing how students are responding to a self-directed curriculum design where engineering students are accessing learning interventions to enhance their learning experience when using 1:1 mobile device technology.

APPROACH
This study approach is focusing on answering the following questions:
How do engineering students use their 1:1 mobile devices for self-directed learning?
What learning motivation perceptions do engineering students have when they are making choices about using a 1:1 mobile device for their learning?
How does using a 1:1 mobile device translate into improved learning outcomes?
How does the improved learning outcomes foster a culture of innovation?
Finding answers to these questions is important for this study to provide academic rigour identify learning motivations that may prove useful for curriculum designers who are interested in developing self-directed learning pathways. It is accepted, technology is a student directed and socially accepted variable that is proving to be an important 'value-add' to the learning spaces of higher education students.

RESULTS
An analysis has shown that student motivation is influenced by motivation variables when curriculum interventions are used in engineering courses. The data suggests that student perceptions of learning motivations can be an important factor to influence the level of engagement when using 1:1 devices for learning. Curriculum designers and course facilitators may benefit from implementing selective interventions with the aim to encourage higher order thinking when problem solving.

CONCLUSIONS
Engineering curriculum designers will benefit from this research when considering how best to implement 1:1 mobile devices as a motivating factor for learning. Learning interventions are an important factor in influencing student perceptions of motivation to learn when using 1:1 mobile devices

KEYWORDS
1:1 mobile devices, engineering educational research, engineering learning.

Introduction

'Learning how to learn' is a paradigm not often heard within engineering education literature, however, it is broadly accepted across the education industry as a premise to equip self-directed learners with the knowledge and skills to recognise when effective learning is occurring. Sustaining a learning culture that fosters innovation linked to higher order thinking skills is a challenge for the most prestigious of universities, however, if contextualised within the framework of student motivation theory and practice, it may be possible to understand the benefits 1:1 mobile devices (1:1 device include iPad, mobile phone, Tablet or similar handheld Wi-Fi or Internet accessible device) can contribute to student perceptions and engagement for learning to achieve improved learning and assessment outcomes.

The motivational factors driving engineering students to use 1:1 mobile devices for learning is not fully understood. Alternatively, students could strategically perceive the use of 1:1 mobile devices as a means to source unprescribed supportive curriculum resources equally as important to the instruction and content prescribed by the curriculum. The challenge is for engineering curriculum designers and facilitators to understand the self-directed learning benefits that may arise from the use 1:1 mobile devices, and to leverage its benefits to improve student perceptions and engagement for learning outcomes. This research paper considers this contention and attempts to explain what is occurring and demonstrate how curriculum designers, facilitators and students may benefit from promoting 1:1 mobile devices within learning spaces.

To place this research study into context; as an educator, I have observed the introduction of 1:1 mobile devices into the hands of students and observing their use as a source of entertainment and on occasions being used for their learning. It became anecdotally apparent, educational policy makers were keen to embrace 1:1 mobile devices, in particular iPads as a marketing exercise, explaining to parents and students this will improve your child's ability to learn and access to a 21st Century education using technology. Of course, economic benefits it offered to educational institutions wanting to shift the responsibility of providing computer devices within the learning space to a user pays model may have had something to do with it too. Bring Your Own Device (BYOD) is universally accepted in educational institutions; although before its introduction very little research could explain any links to improved student engagement and learning. This presented itself as a challenge; to research and provide evidence about the benefits 1:1 mobile devices could bring to student perceptions and engagement for self-directed learning.

Deakin University were implementing changes to their Engineering curriculum. It proposed to transition from a traditional delivery (Lecturer style) to self-directed Object Design Based Learning (ODBL). To facilitate developing student research skills, 1:1 mobile device were seen as a complimentary technology to facilitate access to course materials and also, to have access to the Internet to research for additional educational and project resources, and hence support the problem solving process. This presented a unique opportunity to explore the effectiveness of 1:1 mobile devices as a technology to support self-directed learning and attempt to measure student learning perceptions and whether this could be a way to substantiate self-directed learning to achieve measured learning outcomes.

A literature review identified two models to measure both learners' pre-perceptions and post-perceptions of self-directed learning motivations. Pre-perceptions model proposed by Lucy Guglielmino's (1977), Self-directed Learning Readiness to Learn Scale (SDLR). Post-perceptions of self-directed learning motivations modelled by Jan Vermunt (1977), Inventory of Learning Styles (ILS). Both models have provided a foundation for this research study. Each body of research from Guglielmino and Vermunt provide a divergent insight into explaining what is influencing and motivating engineering students to use 1:1 mobile devices in their engineering learning spaces. The social acceptability of 1:1 mobile devices creates a synergy between the public and private world of the learner. In the same learning space, it

facilitates interaction amongst course facilitators and learners, creating opportunities to develop a culture of innovation through effective leaning interactions and curriculum design.

Self-directed Learning Readiness to Learn Scale (SDLR)

Guglielmino, L., (1977) cites the Self-directed Learning Readiness to Learn Scale (SDLR) was developed in response to high attrition rates in higher education courses. She states that should course selectors be able to evaluate the background of candidates before selection, the trend may be curved (Dressell and Thompson, 1973). Guglielmino (1977) developed the Self Directed Learning Readiness to Learn Scale (SDLR), using the Delphi methodology, where the opinions of a panel of experts identified a hierarchy of personality characteristics and attributes that were highly regarded in self-directed learners (Helmer, 1966). The expert panel's recommendations helped to refine a sequence of questions that may be used by higher education providers to determine an individual's readiness for self-directed learning (Guglielmino, 1977).

The assumptions of the SDLR suggest there are certain behaviours and personality characteristics that distinguish highly self-directed learners from those who are less self-directed. That the person responding to the self-directed learning readiness scale answered truthfully (Guglielmino, 1977). The SDLR instrument has been widely accepted and referenced within the literature as a means to determine a student's readiness to learn. The study showed the key learning behavioural factors included (Guglielmino, 1977):

1. Openness to learning opportunities,
2. Self-concept as an effective learner,
3. Initiating and independence in learning,
4. Informed acceptance of responsibility for one's own learning,
5. Love of learning,
6. Creativity,
7. Positive orientation to the future, and
8. Ability to use basic study-skills and problem-solving.

Highly directed learners exhibit initiative, independence, persistence, accepts responsibility and views problem solving as a challenge, not obstacles, self-disciplined and has a high degree of curiosity, one who has a strong desire to learn, has basic study skills, can use time efficiently, can develop a plan and is goal orientated (Guglielmino, 1977) (Barnett, Jackson, Louis and Algozzine, 1976). Guglielmino (1977) acknowledged that the SDLR instrument was limited to pre-course prediction, however, in combination with a measurement of student motivation, the secondary instrument may assist in providing a more accurate prediction of student behaviour towards their self-directed learning (Guglielmino, 1977) (Cooley and William (1971).

Inventory of Learning Styles (ILS)

Vermunt (1998) proposed a constructivist approach to studying learning styles, with the aim to develop a general model that could explain students' perception of learning and motivations. Vermunt used the word, 'Styles', and is synonymous with the word 'perceptions'. Vermunt developed a questionnaire to measure responses to a list of 'Inventory of Learning Styles' (ILS) (Vermunt, 1988). The inventory included factors relating to cognitive processing, metacognitive regulation, mental learning (to show how student's perceive their learning) and learning orientations (learning motivations) (Vermunt, 1988).

The Vermunt's Inventory of Learning Perceptions includes (Vermunt, 1988):

1. Meaning directed - deep processing strategies, self-regulation and learning viewed as a personal construction;
2. Reproduction directed - surface processing strategies, dependence on external regulation, learning viewed as intake of knowledge, and desire to demonstrate ability;
3. Undirected - poor self-regulation, ambivalence in learning orientation, and value given to external sources of help; and
4. Application directed - strong vocational orientation to learning and a belief that learning is the use of knowledge.

Vermunt (1998) is concerned about how to deliver high quality learning within short time frames of higher education courses. Instructional course designers ignored the cognitive-psychological research on learning processes. Traditional instruction is premised on the Institution directing how learners should behave to achieve assessment outcomes. In contrast, self-directed learning is the process of transferring knowledge as an 'Active Process' where the student builds up internal knowledge for personal interpretation that is constantly changing and evolving under the control of the learner (Duffy and Jonasen, 1992).

Learning Interventions – Inclusion of Bonus Material

In addition to the standard curriculum design notes and PowerPoint presentations, additional resources were included under a new folder titled, 'Bonus Materials'. The bonus materials included resources that '*added value*' by encouraging self-directed learning and prompting the student think about possible questions. The 'Bonus Materials' referred to in this research study is defined as 'Learning Interventions'. An example of learning intervention; Multi-meter simulation - During the learning, students will use an online simulation using their 1:1 device (1:1 device may include an iPad or mobile phone with a browser that has access to the Internet.) The facilitator will encourage the students to use the simulation and find answers to their questions to foster higher order thinking to support a learning concept. This intervention appeals to learners who are self-motivated and want to construct meaning for themselves about the concept taught aligns with Vermunt's (2008) meaning Directed - Personal Motivations. A balance of different interventions to appeal to a range of students learning motivations, extending to Reproduction Directed - Learning Motivations, Undirected - Ambivalent to Learning, and Application Directed - Career Motivations, It is through the curriculum design incorporating learning interventions that the facilitator is able to create a rich self-directed learning space.

Students were encouraged to develop a curiosity to search for the interventions using their 1:1 mobile device technology, extending their own predisposition towards their own self-directed learning motivations. Ultimately, the use of learning intentions is to inspire and motivate students to develop higher order thinking to then want to search out solutions to problems that the existing course and intervention materials is unable to answer. Therefore, the student is self-activating inquiry skills to go beyond their current knowledge and understanding of the assessment outcomes.

Two weeks before the final examination, students were then asked to complete a quantitative online survey using likert-scale questions to measure the student's learning perceptions about their motivations for self-directed learning when using 1:1 mobile devices.

Research Approach

This study has adopted both models and created a hybrid questionnaire instrument (See Table 1). The new survey instrument based on Guglielmino's SDLR (1977) and Vermunt's ILP (1998) aims to identify the variables that can be measured to determine how students are perceiving their use of 1:1mobie devices for self-directed learning. Using the premise of the SDLR and ILP survey instruments, a modified questionnaire of twenty-five targeted

questions was developed as an online survey. Both studies aimed to measure different variables. The newly developed hybrid survey instrument would be directed to identify pre and post perceptions that may explain how students' self-directed learning and motivations are occurring; and potentially provide an understanding about the effectiveness of the learning interventions curriculum design when using 1:1 mobile device technology.

Table 1 - Guglielmino (1977) Self Directed Learning Readiness to Learn Scale and Vermunt (2008) Learning Perceptions of Engagement – Variables of learning motivations

<table>
<tr><th>Guglielmino (1966) Self-directed Learning Readiness Scale. Perceptions - Micro Level</th><th>Vermunt (2008) Learning Styles (Perceptions) of Engagement. Motivations -Macro Level</th></tr>
<tr><td>1. Openness to learning opportunities</td><td rowspan="2">1. Meaning Directed - Personal Motivations</td></tr>
<tr><td>2. Self-concept as an effective learner</td></tr>
<tr><td>3. Initiative and independence in learning</td><td rowspan="2">2. Reproduction Directed - Learning Motivations</td></tr>
<tr><td>4. Acceptance of responsibility for one's own learning</td></tr>
<tr><td>5. Enjoyment of learning</td><td rowspan="2">3. Undirected - Ambivalent to Learning</td></tr>
<tr><td>6. Creativity</td></tr>
<tr><td>7. Future orientation, and</td><td rowspan="2">4. Application Directed - Career Motivations</td></tr>
<tr><td>8. Ability to use basic study and problem-solving skills.</td></tr>
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Hypothesis

HYPOTHESIS states: If, 1:1 mobile devices then there will be an improved perception of student engagement in the engineering course unit of study. If, a measured perception of student engagement does exist, then, this will lead to a measured learning growth from the unit of study.

Sample Size: 25 students (Diploma of Engineering) – 14 responses returned

Results and Analysis

Pre-perceptions to Learn - Table 2 - Part A - Q.7.shows 93 per cent of respondents have a pre-learning motivation to use a 1:1 mobile device to support their learning. Q6.acknowledges respondents pre-learning motivation to value education as a means to express creativity, however, contrasting Q2. may suggest there is a motivational barrier or lack of confidence towards realising that creativity. Q3. and Q4. may suggest the pre-existing barrier(s) is linked to the respondent been unsure about whether the intended course of study will meet their needs and allow them to be creative. Q8. showed 57 per cent of respondents were showing hesitation towards a curriculum design that uses open-ended questions, suggesting the learner has a pre-learning perception that needs a curriculum

design that is sufficiently scaffolded to achieve success. Pre and post enrolment messages need to be considered within the curriculum design to reassure the learner they can overcome any hesitation and can achieve their personal learning goals through the proposed engineering course. Q1 shows 79 per cent of respondents have a strong pre-motivation to choose a curriculum design that aligns with their personal career aspirations and embrace new challenges within the world at large. The importance of the results shows prospective engineering students come with pre-learner perceptions and these need to be considered when marketing courses and matching post-enrolment expectations within the curriculum design.

Table 2: PART A - Guglielmino Focus – Pre-Perceptions to Learn, and PART B – Vermunt Perceptions of Self-Motivation to Learn

PART A – Guglielmino Focus – Pre-Perceptions to Learn	Agree	Standard Deviation
Q1. Learning enriches my understanding of the world, and I like to embrace new challenges.	78.6%	0.68
Q2. My ideas are inspirational to others; however, I never seem to be able to implement them myself.	28.6%	0.80
Q3. I can learn from others, however, I prefer to contribute to my own learning by deciding what, how and when I will be learning.	71.4%	0.78
Q4. I like to be given the course notes in advance, so I can plan and take responsibility for my own learning.	64.3%	1.14
Q5. I enjoy learning because it empowers me to make good decisions.	85.7%	0.73
Q6. Learning inspires me to be creative and to think about new ways to solve problems.	85.7%	0.75
Q7. I like to experiment and use online technologies that help me to learn.	92.9%	0.65
Q8. I find it difficult to learn when open-ended questions are given, and when there is no set answer.	57.1%	0.91
PART B – Vermunt Perceptions of Self-Motivation to Learn	**Agree**	**Standard Deviation**
Q9. I place importance on the views of authors in textbooks.	42.9%	0.92
Q10. I like to be provided with explicit learning resources that explain theoretical concepts step-by-step.	85.7%	0.73
Q11. I find it helpful to take the initiative and write out possible questions and their answers to revise the course material.	42.9%	0.94
Q12. To test my learning progress, I like to complete online quiz questions and self-tests.	71.4%	0.97
Q13. I find it difficult to know by myself, if I have successfully learnt the course content.	42.9%	1.01
Q14. I feel confident, that if I have any misunderstandings about my course content, I can find the answer using online library resources.	50.0%	1.22

Table 3 - PART C – Perceptions of Self-Motivation to use 1:1 Mobile Device to Learn Perceptions of Engagement – Variables of learning motivations.

PART C – Perceptions of Self-Motivation to use 1:1 Mobile Device to Learn	Agree	Standard Deviation
Q15. I like to use an Internet connected 1:1 device (iPad, mobile phone, Tablet or similar handheld Wi-Fi or Internet accessible device), so I can look up facts to test the 'truth' about what I am learning.	64.3%	0.83
Q16. I like to be a member of an online learning community facilitated by an educational leader.	42.9%	1.01
Q17. Playing music on my 1:1 device (iPad, mobile phone, Tablet or similar handheld Wi-Fi or Internet accessible device), at the same time as I am learning helps me to concentrate.	35.7%	1.38
Q18. I like to use my 1:1 device (iPad, mobile phone, Tablet or similar handheld Wi-Fi or Internet accessible device), to learn about career pathways and future employment trends.	57.1%	1.01
Q19. It is my perception that an online learning experience is better than attending lectures, tutorials, and practical activities.	42.9%	1.44
Q20. It is my perception that I am more likely to succeed, if I am using a 1:1 device (iPad, mobile phone, Tablet or similar handheld Wi-Fi or Internet accessible device), to access online resources for learning.	50.0%	1.09
Q21. When attending supervised course lectures, tutorials, or workshops, do you consider using a 1:1 device (iPad, mobile phone, Tablet or similar handheld Wi-Fi or Internet accessible device), an essential tool for active learning?	35.7%	0.83
Q22. If you used your 1:1 device (iPad, mobile phone, Tablet or similar handheld Wi-Fi or Internet accessible device), to access any of the 'Bonus Material', did the 'Bonus Material' motivate you to explore outside of the school of Engineering portal content for further clarifications and/or answers via the Internet?	42.9%	1.20

Perceptions of Self-motivation to Learn - Table 2 - Part B – Q.10 shows 86 per cent of respondents have a perception of learning that includes the need to be provided with a curriculum design that includes explicit resources that explain theoretical concepts step-by-step. This may suggest students are motivated when the curriculum design is inclusive and well supported by an expert. Students are motivated when '*face-to-face'* learning includes current knowledge delivered by experts, which may explain Q.9 showing 43 per cent of respondents are less motivated by impersonal knowledge delivered via text books. Q13. showed 43 per cent of respondents have a perception of learning that acknowledges their need to receive timely feedback from their course facilitator to know learning has occurred. Q14. shows 50 per cent of respondents have a perception of learning that includes a need to have access to online library resources to find answers to misunderstandings. Q13. Shows 71 per cent of respondents had a perception of learning that included a curriculum design that included pre-loading of course content and post-learning testing using online quiz questions for self-testing of curriculum content. The importance of the Table 2 - Part B is to acknowledge respondents undertaking engineering courses have a perception that they are more likely to be self-motivated when they have access to a 1:1 mobile device as a tool to support their learning.

Perceptions of Self-Motivation to use 1:1 Mobile Device to Learn - Table 3 – Part C – Q.15 shows 64 per cent of respondents have a perception that using a 1:1 mobile device is a valid tool to allow access to online resources to validate learning to test the truth about what is been learnt. Question 22 showed 43 per cent of respondents held a learning perception that learning interventions targeted to learner motivations are useful. Question 18 shows 57

per cent of respondents indicated targeted learning interventions linked towards career pathways are aligned with supporting student perceptions of learning. Q22 showed 43 per cent of respondents were willing to '*trend*' towards targeted learning interventions that build student confidence to go beyond the curriculum design content and search out solutions to broader problems via online sources. In summary, the data suggests that perceptions of student motivation towards learning may be influenced through effective curriculum design that supports facilitators to promote 'Active' self-directed learning using 1:1 mobile devices.

Conclusion

The research has shown pre and post learning perceptions exist and when considered during the curriculum design process can play an important role towards influencing engineering students to be self-directed when learning. In addition, 1:1 mobile devices support students to be self-directed, and when considered during the curriculum design process may support student's pre and post learning perceptions. A new paradigm for future engineering curriculum course design may exist, however, further research is needed to identify the learning interventions that align with 1:1 mobile devices as a tool to foster 'Active' self-directed learning spaces.

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