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Polytechnic students' perspectives of a blended problem-based learning approach in Singapore

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Blended learning has become an integral component of the curriculum in institutes of higher learning (IHL) worldwide. Problem-based Learning (PBL) is a constructivist learning approach that can facilitate the development of 21st-century competencies such as self-directed learning (SDL) and collaborative learning (CL). This study investigated if there are any differences in Polytechnic students' perceptions of self-directed learning and collaborative learning between the blended PBL design and the face-to-face PBL design in terms of self-directed learning and collaborative learning in Singapore. The study adopted a quasi-experimental approach, with 56 student participants completing a 36-item validated pre/post survey instrument (MSDLCL). Statistical analyses suggested that in both PBL approaches, students' perceptions of self-directed learning with technology and collaborative learning increased significantly. Focus group discussion results suggested that while students were motivated to complete the assigned PBL tasks, they preferred to conduct collaborative learning activities in person and work on self-directed learning activities online.

Keywords: Blending learning, Problem-based Learning, Technology-enhanced learning

Background

The COVID-19 pandemic in 2020 saw a dramatic pivot in teaching and learning methods in institutes of higher learning (IHL) worldwide. With minimal preparation time, IHLs were forced to shift the mode of delivery of the entire curriculum from predominantly face-to-face to fully online. Even though most IHLs including Singapore already had e-learning practices in place, the intensity of the online pivot during COVID was discombobulating to many teachers and students alike (Coman et al., 2020; Gauntam & Gautam, 2021). As most institutions return to face-to-face learning and interactions, many have incorporated blended learning as a permanent part of the curriculum (Lim & Graham, 2021; Ng, 2021; Reimers & Schleicher, 2020). It has been suggested that blended learning can be combined with Problem-based Learning (PBL) to create constructivist learning environments (An, 2013; Donnelly, 2017). The purpose of this paper is to investigate IHL students' perceptions of the blended Problem-based Learning (PBL) approach compared with the face-to-face PBL approach in terms of self-directed learning and collaborative learning with and without the use of technological tools, both of which are key constructivist learning outcomes of PBL (Hmelo-Silver, 2004; Loyens et al., 2011). The study is done in the context of a digital media course at a polytechnic in Singapore. This research hopes to provide lesson designers with ideas to enhance self-directed learning and collaborative learning within students' blended PBL experience. The research questions for the study are:

RQ1: What are the differences in students' perceptions towards self-directed learning and collaborative learning with and without technology between the blended PBL approach and the face-to-face PBL approach?

RQ2: What are the students' learning experiences of the PBL course in the blended and face-to-face approaches in terms of self-directed learning and collaborative learning?

Literature Review

This study is guided by constructivism as the theoretical framework. At the heart of constructivism is the view that knowledge is not transferrable but something the learner has to actively master through meaningful experiences (Schmidt, 1993). According to cognitive constructivist theories, learning occurs when the learner struggles through perturbations (Schmidt, 1993). Problem-based learning (PBL) is a constructivist approach where students learn through solving authentic and complex problems (Barrows, 1996). Blended learning is a term that has been used broadly in the literature (Graham, 2021; Hratinski, 2019). This has led to a wide variety of blended learning designs with inconsistent outcomes (Fuller, 2021; Graham, 2021; Hratinski, 2019). For a tighter scope as recommended by Fuller (2021), this research aligns with Allen and Seaman (2010)'s approach to blended learning which adopts a 30 to 80% proportion of online instruction and a significant reduction of face-to-face learning. Organising blended learning around PBL principles has been found to create constructivist learning environments (An, 2013; Donnelly, 2017). The wide array of Information and Communication Technology (ICT) tools go beyond offering alternative modes for content delivery and can augment the

constructivist aims of PBL. The aim of this study is to investigate how blended learning could support PBL to enhance self-directed learning and collaborative learning, which are among the key constructivist outcomes of PBL (Hmelo-Silver, 2004; Loyens et al., 2011). Studies on blended PBL have yielded promising but inconsistent results in terms of self-directed learning and collaborative learning. For collaborative learning, de Jong et al. (2017)'s study on health Master's students found collaboration feasible even with language differences. Participants found synchronous online collaboration comparable to face-to-face collaboration with no disruption to student roles or depth of discussion. Walker (2014)'s study on seven post-graduate students focused on online blog discussions with no facilitator present. The study found positive patterns of collaborative learning with evidence of higher-order thinking and reflective learning. The students managed to self-regulate in times of conflict and felt that having everything written out facilitated their learning progress. However, in Tambouris et al. (2017)'s study, which involved 12 postgraduate students, half the participants found it uncomfortable to have their opinions recorded online and so they held themselves back, affecting the depth and the breadth of collaborative learning.

For self-directed learning, a study of 188 math students found that online resources such as YouTube videos and e-books supported self-directed learning (Amin et al., 2021). Students welcomed the flexibility to access the resources at their own pace and time. Walker (2014) found that blogs and wikis facilitated self-directed learning online in the absence of a facilitator. Students showed evidence of wider reading and better reflection, negotiation and interpretation skills. However, students expressed a frustration for lack of feedback on their work online and at the end of the PBL cycle. Tambouris et al. (2014) found that while ICT tools facilitated self-directed learning, students found the amount of information online overwhelming and sought support.

Until now, limited studies have been conducted on IHL students in Singapore to investigate their perceptions towards self-directed learning and collaborative learning comparing face-to-face and blended PBL. The findings of this research can contribute to this research gap and offer some insights into students' perceptions and learning experiences with regards to these constructs in the different modes of PBL in the Singapore context.

Methodology

A quasi-experimental study was designed to collect quantitative and qualitative data to investigate the Polytechnic students' perceptions towards a blended PBL approach and a face-to-face PBL approach. Prior to commencing data collection, ethical approval was sought and obtained from the Nanyang Technological University Institutional Review Board (IRB-2022-784). The students were provided with a detailed explanation of the study's purpose, procedures, and potential benefits. Written consent was obtained from all 56 student participants for the study. Those who are below the age of 21 produced written parental consent. The students taking the digital media course had been pre-assigned into four classes by the polytechnic's administrative offices. Thus, pure random selection of the participants was not feasible. For the quasi-experiment, the four classes of students were divided into two groups. One group, comprising 29 students in two classes, went through a face-to-face PBL approach. The other group, comprising 27 students in two classes went through a blended PBL approach. The students went through two cycles of PBL on different topics. Each cycle comprised two sessions, lasting four and a half hours each. The face-to-face PBL group went through the entire PBL course in a physical classroom setting. In the blended PBL group, the students began the PBL cycle with a problem scenario posted online asynchronously. Students then met online synchronously with the facilitator to define and break down the problem. They worked collaboratively with their peers online through a combination of synchronous and asynchronous modes. Self-directed learning activities such as readings and research activities were incorporated as asynchronous learning. Students in both groups completed each PBL cycle in face-to-face classrooms where they presented their problem solutions to the facilitator. They assessed each other's work and ended the PBL cycle with a reflection activity that they completed online asynchronously. Table 1 describes the organization of the blended and face-to-face PBL approaches.

Table 1: Organization of the PBL cycles in the study

		Face-to-face PBL group	Blended PBL group
PBL Cycle 1	Session 1	Face-to-face (4.5 hours)	Online (4.5 hours)
	Session 2	Face-to-face (4.5 hours)	Face-to-Face (4.5 hours)
PBL Cycle 2	Session 1	Face-to-face (4.5 hours)	Online (4.5 hours)
	Session 2	Face-to-face (4.5 hours)	Face-to-Face session (4.5 hours)

Data Analysis

To address the first research question, students completed a 36-item Likert-scale validated survey (MSDLCL from Choy et al., 2016) before PBL Cycle 1 and after PBL Cycle 2. MSDLCL was designed based on Pintrich's MSLQ (Pintrich et al., 1993) and validated in the Singapore context. The survey collected data on students' perceptions of self-directed learning, self-directed learning with technology, collaborative learning, and collaborative learning with technology of their blended PBL or face-to-face PBL experience. To address the second research question, 28 out of the 56 students participated voluntarily in four separate focus group discussions, each lasting one hour, to share their learning experiences in the digital media course.

Results

RQ1: Differences in students' perceptions towards self-directed learning and collaborative learning with and without technology between the blended PBL approach and the face-to-face PBL approach

To investigate the differences in the perceptions of students in blended PBL group versus face-to-face PBL group, a paired sample t-test was conducted to find out their perceptions towards self-directed learning (SDL), self-directed learning with technology (SDLT), collaborative learning (CL), and collaborative learning with technology (CLT), and a pairwise t-test was used to compare the means for the face-to-face group and the blended PBL group before and after the 4-week intervention. The descriptive statistics showed that there were increases in all four variables and in both groups. The biggest increases could be found in self-directed learning from the face-to-face group (from 3.30 to 3.80) and in collaborative learning in the blended PBL group (from 4.00 to 4.44) (see Table 2).

Table 2: Comparisons of students' perceptions of SDL, SDLT, CL, and CLT for both groups.

Variable	Face-to-face PBL (n = 29)			Blended PBL (n = 27)		
	Pre-intervention	Post-intervention	T	Pre-intervention	Post-intervention	T
	<i>M (SD)</i>	<i>M (SD)</i>		<i>M (SD)</i>	<i>M (SD)</i>	
SDL	3.30 (.1025)	3.80 (.867)	-3.64**	3.66 (.734)	3.84 (.676)	-1.38
SDLT	3.73 (.847)	4.05 (.761)	-3.22**	3.92 (.642)	4.24 (.577)	-2.20**
CL	4.15 (.706)	4.40 (.656)	-2.01**	4.00 (.940)	4.44 (.560)	-3.26**
CLT	4.25 (.612)	4.40 (.636)	-1.39	4.30 (.727)	4.46 (.544)	-1.54

*p < .05; **p < .01.

Pairwise t-test comparisons showed that there are significant differences in both groups. For the face-to-face group, students' perceptions of self-directed learning, self-directed learning with technology and collaborative learning increased significantly. Collaborative learning was quite positive before the intervention ($M = 4.15$), it further increased to 4.40 towards the end of the intervention ($t = -2.01$, $p\text{-value} < .01$). Although there are no significant differences in collaborative learning with technology, students' perceptions remained very positive at 4.25 before the intervention and reach 4.40 after the intervention. This result was consistent with the common practices in Polytechnic where collaborative learning was highly encouraged in all the courses. For the blended group, students' perceptions of self-directed learning with technology and collaborative learning increased significantly. Although there are no significant differences in self-directed learning and collaborative learning with technology, students' perceptions remained very positive before the intervention, particularly for collaborative learning with technology ($M = 4.30$). This is consistent with students' familiarity with collaborative learning with technology in the Polytechnic.

RQ2: What are the students' learning experiences of a digital media course in the blended PBL and face-to-face PBL instructional approaches in terms of self-directed learning and collaborative learning?

To explore their learning experiences with regard to self-directed learning and collaborative learning, a purposive sample of 28 students were invited to participate in a one-hour focus group discussion. For self-directed learning, even though the quantitative results suggested positive perceptions among the face-to-face group, where they were able to set their learning goals and search for information on the internet to help them understand the topics better, they felt that it would be a better experience if the self-directed activities could be conducted online. The immediate presence of the lecturer and their peers in class made it convenient for them to ask questions and get answers immediately. In this way, they felt that the instructor-led and peer-supported environment could have restricted their self-directed learning experience. One student commented:

Our [facilitator] will explain and go through all the answers and stuff so we get to see the answers and then get to his explanation as well...if that's the case, we stay in our comfort zone.

On the other hand, students in the blended PBL group felt that the absence of a lecturer to come to their immediate aid forced them to become more self-directed. One student summed it up:

I think that is like very natural to just start researching things on your own, which is why I think that this form of blended learning encourages self-directed learning.

The blended PBL students also enjoyed the flexibility of time and space of online self-directed learning for activities that were non-time-sensitive. For collaborative learning, students in the face-to-face PBL group felt that it was very manageable due to the physical proximity of their friends and lecturer in class. One student said:

If you don't know the answers, it's easier for you to get help when you're in person because like you can just ask them just face-to-face.

On the other hand, the blended PBL group felt that collaborative learning can become challenging during online sessions, especially when it was being done synchronously. One reason cited was that the flexibility given to students to choose their time for learning made it sometimes difficult to communicate. One student commented:

It's kind of difficult because not everybody will be on the same page because everyone's like too flexible and too free to do their own things.

The findings from the focus group discussions suggest that while the students were able to complete the self-directed learning and collaborative learning activities designed into both the blended and face-to-face PBL lessons, if there were given a choice, they would prefer to have the self-directed learning activities online and the collaborative learning activities conducted in person.

Conclusion

This research aims to investigate IHL students' perceptions of a blended PBL approach compared with a face-to-face PBL approach in terms of self-directed learning and collaborative learning in the context of polytechnic students in Singapore. The quantitative results of the study suggested that a blended PBL approach is comparable to the more established face-to-face PBL approach in the area of students' self-directed learning with technology and collaborative learning. However, in terms of learning experiences, the qualitative findings suggested that students preferred the blended PBL approach for self-directed learning activities, whereas collaborative activities were more enjoyable for students in face-to-face setting. This study's limitations include a relatively small sample size, the intact groups assigned to the interventions, and the short duration of the intervention. The study is also limited to a sample of students in one course in a single polytechnic. Future directions include an expansion of implementation to account for these factors, as well as getting the lesson designer and facilitator perspectives of the blended PBL instructional method. Nevertheless, it is anticipated that this offers a starting point to support lesson designers to explore the possibilities of integrating blended PBL into more courses in the Institutes of Higher Learning.

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