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The Journal of Problem-Based Learning is an interdisciplinary/multidisciplinary professional journal showcasing the scholarship and best practice in Problem-Based Learning.
Article topics can be any areas related to PBL and similar approaches to learning and teaching (e.g., enquiry, inquiry, abilities, practice, situation or solutions-based) that facilitate the development of a suite of metacognitive and process-oriented abilities. We are interested in scholarly papers that report on the paradigm shifts in education - experiences with, and developments in educational philosophy, curriculum design and implementation across different professions, countries, contexts, and cultures.

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COVID19 – The Catalyst for Educational Change: Applying/Using e-PBL for Accelerated Change

Margaret McMillan

School of Nursing and Midwifery, University of Newcastle, Australia

Editorial

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Recently Cheju Halla University (CHU) demonstrated a willingness to embrace more blended forms of delivery including a greater reliance on e-learning. The catalyst for the change was COVID19, a major disruptor of all societal functions. This particular pandemic has led to a dramatic loss of human life worldwide and presents an unprecedented challenge to public health, food systems, education and the world of work (WHO 2020).

For the annual PBL conference this year, a webinar replaced the usual face-to face-face event. It was clear that CHU like the higher education sector elsewhere, was severely impacted by the pandemic. All stakeholders in higher education were caused to change by the spread of COVID19 (The Lancet 2020). Parties to the Tokyo Convention noted in November that the challenges of COVID-19 have made online and blended learning the new normal and sought to recognise online learning to prevent further disruption to students (Sharma, 2020).

Revolutionary change in education needed to happen quickly. The term 'digidemic' has been coined is to describe the rapid widespread digitalisation of learning that has affected many universities across the globe, where the traditional face-to-face teaching has been replaced with distanced teaching (Alam, 2020). However, some processes and people needed to change more than others. Key personnel in universities across the world knew that they needed to support students first and foremost in the COVID19 crisis if ongoing enrolment and completion of studies was to be assured. Moving towards more flexible modes of delivery and recognition that learning outcomes can be met in a variety of ways is essential (Sharma, 2020).

Problem-based Learning (PBL) curricula provide scaffolding for integration of ideas and facilitate modification of learning activities when necessary. Student-centered, self-directed and work-integrated Learning are features of PBL, but e-Learning platforms would need to be developed in a way that aligns with PBL curriculum design.

From the conference papers it was easy to see that a case study centered on population and preventive health would be a useful addition for student learning. Presentations centered on the manner in which

- Change in approaches to learning was an imperative in the circumstances imposed by a pandemic
- PBL frameworks facilitated rapid responses such as the capacity to move towards more student-centered and self-directed learning
- Actual case studies within the webinar demonstrated the desired graduate abilities such as problem-framing and solving, therapeutic intent, critical appraisal of novel situations, meaningful communication, collaborative practice, giving and responding to feedback and information literacy.
- There was a need for mental health support for students and others impacted by changing circumstances.
- Paradigmatic shifts are impacted by culture but can feature cultural nuances around ethical

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dilemmas for older people managing life transitions.

- There was a need for differentiation across academic and technical roles in educational design initiatives.
- A digital future that we had not fully embraced, was now more desirable and possible.
- A vision for educational change must be a shared one and be backed with sufficient resources.

It is clear that information literacy is more important now than it ever was and must be a feature of curriculum design and implementation in a way that prepares students for the real world. Generally, students globally have responded well to changes imposed by COVID19, because they were natives of the digital age. But some still needed support (Aristovnik et al. 2020). There was a clear demonstration of a need to cause students to embrace student-centered and self-directed learning in a way that helps prepare them for work and life where reliance on technology is now a feature of most transactions.

During the on-line symposium, it was shown that the professional development of academics (with the teacher as learner) was also needed for existing and new generations of staff members if curriculum renewal efforts were to pivot successfully (Little & McMillan 2019). It is desirable that some of this professional development also be conducted on-line and reflect the values and principles of PBL. Teachers need to appreciate student experiences with self-directed and student- centered learning.

The key to achieving contemporary student-centered learning outcomes that reflect the abilities needed in real life, is in sound educational design, especially the use of authentic case studies. On-line PBL allows for a broad range of stimulus material to be used and changed when necessary.

My son is a mature-age paramedic student in his final year of a program using PBL in an on-line mode offered to 200 students for the first time within that particular Australian University. When COVID19 struck, 400 on-campus students had to pivot to the on-line mode. The major impact for his student cohort was the inclusion of the larger group in the e-learning environment. The most negative impact for the original on-line group arose from the expansion of the student group. What changed often as a result of the need to ensure sound population health during COVID19 were the assessment tasks. It is important reminder that for students, assessment equates to learning if it does what it says it will do. Therefore, there is a need to ask 'If I use this assessment task, what learning outcomes am I causing the students to demonstrate?' Much of what we do on-campus can be effectively reconfigured to place the learning event in the digital space. This includes assessment tasks that assure the students that their learning outcomes have been realized.

My key messages here are that educational design matters irrespective of that nature and extent of the use of technology and that teachers are learners too. They need to share the vision for student learning processes and the values and principles underpinning the design and implementation of any curriculum philosophy. Professional development should include the use of the same methodology that we argue is necessary for contemporary students in the digital age. Personal reflections on the webinar experience suggest that the exercise was successful and provided powerful and moving teachable moments. The webinar organizers and participants were able to show how curriculum renewal is possible while retaining the integrity of the PBL framework. Live interactions through facilities for question and answer and chat lines demonstrated a high level of engagement.

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Development and Preliminary Evaluation of an Instrument to Measure Readiness for Problem-Based Learning

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Purpose: This study was conducted to develop and provide a preliminary evaluation of an instrument to measure students' readiness for Problem-Based Learning (PBL). The instrument assessed students' readiness for four main aspects of the PBL environment: problem-solving, self-directed learning, collaborative learning, and critical thinking.
Methods: The Readiness for PBL (RPBL) instrument was trialed in two polytechnics in Singapore. Exploratory and confirmatory factor analyses, as well as internal consistencies, were used to explore the internal structure of the instrument.
Results: The results of the study confirmed that the internal structure of the instrument was tenable within the cohorts that participated in the study.
Conclusions: The results of this study suggest that the RPBL may provide a practical means by which students' readiness for PBL may be assessed, with the goal of enhancing the benefits of PBL environments for these students.

Keywords: Physics education; Learning processes

Original Article

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INTRODUCTION

Since its introduction in 1969 within a Canadian medical school, the use of Problem-Based Learning (PBL) has been growing in popularity. PBL can be defined broadly as a constructivist learning environment in which the focus is on experiential learning, organized around investigation, explanation and resolution of problems (Hmelo-Silver, 2004). In the approach, students learn content and thinking strategies by working on problems in small collaborative groups. A typical PBL session commences with an ill-defined problem. Students must then work together in small groups to address the issues associated with the problem and to address relevant gaps in their own knowledge to arrive at a suitable solution, with a facilitator on hand to guide the students through the process. Apart from the content-related knowledge and skills that students acquire, the process is intended to promote the development of other skills such as critical thinking and problem-solving, as well as both self-directed and collaborative learning competencies (Lieux, 2001; Schmidt, Vermeulen & Van Der Molen, 2006).

Students' Readiness for PBL Environments

Whilst PBL has accumulated many advocates across education sectors, evidence has appeared which suggests that some students find PBL environments challenging. For example, research has shown that, while many students enjoy PBL and find the approach satisfying (Caplow, Donaldson, Kardash & Hosokawa, 1997;Rideout, et al., 2002), not all students are eager to adopt this approach (Alper, 2008;Hamalainen, 2004; Hood & Chapman, 2011). In

one recent study, for example,Fukuzawa, Boyd and Cahn (2017) reported that only 22% of students who had experienced PBL moderately or strongly agreed to a question on whether they would like to attend more PBL class sessions. Furthermore, only 41% of these students indicated that they would like to take another course in which PBL was used. Fukuzawaet et al. also reported that some students' motivational levels were impacted negatively as a result of being unfamiliar with the PBL process.

Recent research has underscored the importance of students' readiness for major transitions within their education journeys. In general, the term readiness in an education context refers to the extent to which students enter a given environment with the attributes necessary to engage in, and benefit from, the learning experiences proffered by that environment (see, for example, Kentucky Department of Education, 2019). In a 2013 report by the ACT (ACT Policy Reports, 2013), which focused on students' readiness for tertiary level studies, they noted that "Many students do not persist in college to degree completion because they are ill-prepared for college and require remedial coursework. Many students also lack the academic behaviors and goals that are needed to succeed in college" (p.2). Various recent studies have confirmed that students' readiness for specific aspects of post-secondary learning environments are important predictors of the outcomes they achieve in such environments. For example, studies have indicated that readiness factors such as students' learning preferences, learning approaches and motivation significantly predict their attitudes to, performance in, and satisfaction with, university life in general (e.g., Agherdien, Mey & Poisat, 2018;Wasylkiw, 2016). Readiness has also been found significantly to predict students' responses to, and performance in, specific types of university learning environments, such as those that rely heavily on information communication technologies (e.g., Tang & Chaw, 2013).

As noted by De Graaff and Kolmost (2003), PBL environments differ from more 'traditional' learning environments in various key ways. Amongst these differences, PBL relies heavily on presenting ill-defined problems to students, rather than clearly-defined tasks that have a single correct answer. PBL also places a strong emphasis on students applying critical thinking skills through both self-directed and collaborative learning processes, which may be emphasized variably in more traditional education contexts. Given these characteristics, it is likely that some students will simply be better prepared, or 'ready', for PBL environments than others, either because of their own background characteristics, or because of their previous exposure to such methods. This level of readiness may, in turn, account for some of the performance and response variability seen across students when they are first exposed to PBL environments at the post-secondary level.

In light of findings which indicate that students can respond variably to PBL environments, it would be useful for institutions that rely on PBL as a primary teaching and learning approach to be able to assess students' readiness for different elements of the PBL environment. This would enable the institutions to develop targeted scaffolding interventions to assist any students who are 'at risk' of underperforming in these environments to reach their full potential. In a qualitative study by Pepper (2010), for example, it was found that a large number of students did not report enjoying PBL because they felt that they needed to be trained to be effective self-directed learners before being exposed to PBL. Belland, Chan and Hannafin (2013) also asserted that it is fallacious to assume that students will automatically be engaged when faced with authentic, problem-based experiences. Suitable scaffolding is essential to promote high levels of student motivation and engagement in these contexts, with the aim of creating learning spaces that are supportive and conducive for all students. How such scaffolding could be offered by individual institutions is a topic beyond the scope of this paper, but there is an emerging body of literature on effective ways in which this can be done (e.g., Ertmer & Galzewski, 2020).

Key Elements of PBL Environments

As indicated, the PBL process requires students to solve problems collaboratively in small groups, and to address any gaps in their knowledge first through self-directed learning, and then by sharing their findings within their groups. Critical thinking will be a key component of the problem-solving process in any PBL environment. As noted previously, PBL environments thus confront students with a range of experiences with which they may have limited prior experience. In particular, PBL places a heavy emphasis on four key processes, two related to students' cognitive processes (problem-solving and critical thinking), and two related to their learning processes (self-directed and collaborative learning).

Problem-Solving. In PBL, students are presented with an ill-defined problem and have to work on this using various prescribed methodologies to arrive at a possible solution. Given its emphasis on the use of ill-defined problems, problem-solving in PBL involves students engaging in the steps of deconstructing the problems they are given, defining these in their own words, finding resources to help them address the problems, and testing out their solutions (see Ertmer & Galzewski, 2020).

Critical Thinking. One of the key rationales proffered by some researchers for using PBL is that it is designed to promote critical

thinking skills (Maudsley & Strivens, 2000). While definitions of critical thinking vary considerably within the literature, most definitions indicate that this form of thinking involves the disciplined conceptualisation, application, analysis, synthesis, and evaluation of information to reach a solution or conclusion (e.g., Bahr, 2010). Given the emphasis on students responding to ill-defined/structured problems presented in PBL, it is inevitable that some form of critical thinking will be required throughout this experience (Savery, 2006).

Self-Directed Learning. Gibbon (2003) defined self-directed learning as "any increase in knowledge, skill, accomplishment, or personal development that an individual selects and brings about by his or her own efforts using any method in any circumstances at any time" (p.2). Self-directed learning is an essential component of PBL environments, because all students must use self-directed strategies to address the problems presented to them in these environments (Hmelo, Gotterer & Bransford, 1997; Ozuah, Curtis & Stein, 2001).

Collaborative Learning. A fourth key element of PBL is collaborative learning (Savery, 2006). Laal and Laal (2012, p. 1) defined collaborative learning as "an educational approach to teaching and learning that involves groups of learners working together to solve a problem, complete a task, or create a product". Laal and Laal further identified the following five aspects as critical in collaborative learning: positive interdependence, individual and group accountability, interpersonal and small group skills, face-to- face promotive interaction, and group processing. In PBL, working in small groups is designed to help distribute cognitive load, as well as to build students' abilities in working as members of teams (Hmelo-Silver, 2004).

Instruments to Measure Readiness for PBL

Despite the potential importance of students' readiness to engage in PBL environments, the authors were unable to locate any generic instruments designed specifically to assess this construct. This was based on a systematic search of all articles with the keywords "PBL" or "Problem-Based Learning" across nine databases: ERIC, EBSCO, Google Scholar, ProQuest Psychology/Education Database, PsycINFO, Sage Journals online, Wiley online, and A+ Education. A small number of papers have been published in which PBL readiness was a stated study focus, but in these cases, the researchers have focused only on specific elements of the PBL environment (most often, the self-directed learning aspect). For example, Leatemia, Susilo, and van Berkel (2016) sought to identify students' readiness to engage in a hybrid PBL curriculum, but focused specifically on their preparedness for self-directed learning. Using a combination of quantitative and qualitative methods across five medical schools in Indonesia, they found that only half of the students had a high level of self-directed learning readiness. While results of this kind do affirm that students present with varying levels of skills required for specific elements of PBL, there is a need for a more comprehensive assessment of PBL readiness.

The authors did identify one study that focused specifically on developing an instrument to assess 'suitability' for PBL environments. Chamberlain and Searle (2005) sought, in their research, to develop a student selection instrument designed to assess candidate suitability for a PBL curriculum. In the study, a sample of 69 volunteer candidates attending an interview for entry to medical school formed 13 teams of 5 or 6 candidates each. Each candidate was then assessed independently by two assessors. Attributes deemed to be suitable and unsuitable for a PBL environment were then identified and used as the content of the instrument. Suitable behaviours included active listening, summarising, reflection, contributing to and complying with group rules, balancing the task with discussion, and respecting and tolerating varied opinions. Unsuitable behaviours for PBL included prejudice toward other people, depreciative behaviours, demeaning people, not valuing comments, egocentricity, and being domineering. The authors reported that the the instrument demonstrated good item discrimination, the potential for good agreement between raters, strong internal consistency, and good acceptability among candidates. Whilst an instrument focused upon suitability for PBL could be potentially be used as a basis for developing a readiness for PBL instrument, the instrument developed by Chamberlain and Searle was also restricted in its focus, including only attributes related to the teamwork element of PBL.

A third instrument reviewed by the researchers was the PBL Attitude Scale developed for a study in a medical school in Turkey. In the study, Alper (2008) administered a survey to 313 first-year students and 136 second-year students of the Faculty of Medicine, Ankara University. According to the author, the aim of the study was to measure students' attitudes toward some facets of PBL. These facets were Problem-solving (PS), Self-Directed Learning (SDL), Group-Based Learning / Co-operative Learning (COL), and Facilitator and Web-Supported Environments. The internal consistency of the instrument was reported to be high at 0.86. No psychometric properties other than instrument internal reliability were reported. Again, while an instrument developed to assess students' attitudes toward PBL could conceivably be adapted to develop a measure of students' readiness for PBL, this instrument (whilst more comprehensive in its coverage of PBL elements) did not focus upon all four aspects of PBL as

discussed previously. In particular, the instrument excluded any consideration of critical thinking, which is one of the four core elements of the PBL approach.

Study Rationale

The research summarized previously suggests that students can exhibit varying degrees of preparedness or readiness to engage in different aspects of PBL, which may produce adverse effects on academic performance or overall learning experiences. Given that many institutions in Singapore now rely heavily on PBL as a learning approach, it would be useful for these institutions to be able to assess students' readiness for these environments before they are exposed to them. This knowledge would then equip the institutions to offer some form of scaffolding for students who are at risk of underperforming in PBL environments. A review of literature, however, indicated that no comprehensive instruments have yet been developed to assess students' readiness for PBL. The purpose of this study, therefore, was to develop and provide a preliminary evaluation of an instrument to assess students' readiness for PBL in a higher education context. It should be noted here that the instrument was not designed to measure students' attitudes toward PBL (which cannot be assessed before students are exposed to PBL), or their behaviors within PBL (which again cannot be assessed prior to their exposure to PBL), but to provide a means by which students' readiness for PBL could be assessed, even before they are exposed to it for the first time.

METHOD

Participants and Setting

Participants were students from two polytechnics, A and B, in Singapore. The number of students who participated from polytechnic A was 315 and that from polytechnic B was 310. Polytechnic A students were drawn from a School of Information, whereas those from polytechnic B were from Information Technology and Business schools. Following initial data screening to remove partially completed surveys, as well as instances of clearly disengaged responses (i.e., respondents who put the same rating for every question), the final numbers of respondents from polytechnics A and B were 275 (87.3%) and 227 (73.2%), respectively. The gender distributions were 44.4% males and 55.6% females from polytechnic A, and 40.1% males and 59.9% females from polytechnic B. The age of the respondents ranged between 17 and 25 years for both polytechnics. For Polytechnic A, the mean age was 18.09 years ($SD = 1.56$), and for polytechnic B, the mean age was 18.68 years ($SD = 1.18$). All participants were Asians, with the majority being Singaporeans (88.7% from Polytechnic A and 93.8% from Polytechnic B). The remainder were from the countries of Malaysia, Indonesia, China, and Thailand. In terms of ethnicities, the respondents were mostly Chinese, Indians or Malays (62.5%, 24.7% and 8.3%, respectively, from polytechnic A, and 87.7%, 7.1% and 3.1%, respectively, from polytechnic B).

Polytechnic A students' learning environment was entirely conducted using the PBL approach for all its full-time diploma programs, whereas polytechnic B's students had a hybrid learning environment, comprising both traditional instructional methods and PBL. During this survey, students from both polytechnics were engaged in a module conducted in a PBL environment. Both groups of students were undertaking PBL for the first time within their respective institutions.

Instrument

The instrument created in this study, the Readiness for PBL (RPBL) instrument, initially included 16 items and utilized a 7-point bipolar statement rating scale. The latter type of scale was chosen for the instrument as bipolar items have been found to reduce acquiescence bias and produce better model fits in instrument analyses (Friborg, Martinussen & Rosenvinge, 2006). Each bipolar item included two full statements to avoid ambiguity and ensure meaningful responses. The instrument developed included two separate components, one focusing on the cognitive processes demanded by PBL environments (problem-solving and critical thinking), and the other focusing on the learning processes associated with PBL environments (self-directed and collaborative learning). These components were included to align with the key components of PBL environments as discussed in the introduction to this paper. Tables 1 and 2 list all items within the full RPBL instrument.

Procedure

Prior to conducting the research, ethics approval was obtained from the researchers' affiliated institution and approvals were also obtained from the two participating institutions. Participants from polytechnic A were new students starting their freshmen semester, while participants from polytechnic B were second year students. Both sets of participants were enrolled in modules conducted using the PBL approach. No participants had attended courses conducted in PBL within their respective institutions at the start of the semester in which the study was conducted. The survey was administered at the end of the first (13-week) semester for both polytechnics.

The instrument was completed online, hosted on the Qualtrics platform. On the day of the administration, online links were sent

Table 1. Item statements in the Readiness for PBL (RPBL) instrument (Cognitive Processes Component)

Subscale	Item Label	Low scoring statement (scored 1 at endpoint)	High scoring statement (scored 7 at endpoint)
Problem- Solving (RPBL_PS)	RPBL_PS1	I find that I cannot understand problems we are given till the lecturer gives his/her solution.	I am able to understand the problems we are given in class with some discussion.
	RPBL_PS2	I find it difficult to use prior knowledge to help me understand problems.	I use prior knowledge to help me understand the problems we are given.
	RPBL_PS3	I am still mostly fuzzy at the end of each class discussion.	I am able to form reasonable conclusions at the end of each class discussion.
	RPBL_PS4	My problem-solving process is usually haphazard.	I use known methodologies to help solve problems.
Critical Thinking (RPBL_CT)	RPBL_CT1	I think it is not necessary to look at multiple perspectives on an issue, only the obvious ones will do.	I am able to look at problems from multiple perspectives.
	RPBL_CT2	I don't think it is necessary to identify the pros and cons of a situation so long as I understand it generally.	I am able to list the pros and cons of a solution.
	RPBL_CT3	I don't think there is a need to justify claims, as long as other people accept them.	I think that people cannot make claims without clearly and logically justifying them.
	RPBL_CT4	Thinking too long and intensely about anything tends to confuse me further.	I can arrange my thoughts logically and see clear relationships among them.

Table 2. Item statements in the Readiness for PBL (RPBL) instrument (Learning Processes Component)

Subscale	Item Label	Low scoring statement (scored 1 at endpoint)	High scoring statement (scored 7 at endpoint)
Self-Directed Learning (RPBL_SDL)	RPBL_SDL1	I try to get by with the class materials given to me.	I generally learn new concepts on my own by research and exploration.
	RPBL_SDL2	I think the facilitator/teacher is primarily responsible for my learning.	I am responsible for my learning.
	RPBL_SDL3	I usually do not need to be told exactly what is expected of me.	In the classroom, I expect the teacher to tell us exactly what we are expected to do.
	RPBL_SDL4	I usually find it hard to form a clear conclusion based on my own ideas.	I can reach conclusions that reflect my ideas and are logical.
Collaborative Learning (RPBL_CL)	RPBL_CL1	I prefer studying on my own.	I enjoy studying with my peers in small groups.
	RPBL_CL2	I am more efficient working alone.	Working in groups makes it faster to arrive at a solution.
	RPBL_CL3	I find it hard to share my ideas in a group.	I find that studying in group helps me to learn better.
	RPBL_CL4	I am not sure I can trust my teammates' contribution to my learning.	I believe that everyone has something to contribute to my learning.

to the students via email. This was done during class time. Students were invited to participate in the survey at the end of their classes. They were encouraged to complete the survey in class and in one sitting so as to minimize any potential survey abandonment. To ensure that all participating classes had the opportunity to complete the survey, however, the survey was left open for up to two weeks. No special incentives were offered to respondents to participate in the survey. Students were told that participation in the survey was voluntary and that they can leave the survey at any point in time.

Prior to the actual survey, a time trial was conducted with a small group ($n = 20$) of students who were not part of the main study within polytechnic A. During this trial, it was found that all respondents were able to complete the survey within 10 minutes. This was deemed to be ideal, as a longer survey could result in fatigue, and subsequent loss of data quality.

RESULTS

Both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) methods were conducted to evaluate the internal structure of the RPBL instrument. First, to provide a preliminary assessment of internal structure, an EFA was conducted on data from the polytechnic A participants. Second, a CFA was used to cross-validate the EFA findings, using data from the polytechnic B participants. IBM SPSS V25 was used to conduct all analyses associated with the EFA, while LISREL V8.80 was used for those associated with the CFA.

RPBL – Cognitive Processes Component

A Maximum Likelihood (ML) extraction was used in the EFA on the Cognitive Processes component scores from polytechnic A participants ($n = 275$), as recommended by Costello and Os-

bourne (2005). The factors extracted were rotated to approximate simple structure using the Direct Oblimin method, allowing factors to correlate in the rotation. Decisions about the number of factors to retain were made on the basis of three alternative sources of information: Kaiser's eigenvalues greater than one criterion; the Cattell scree plot; and a parallel analysis of obtained eigenvalues. These three sources were all considered to reduce the possibility of over- or under-extracting factors from the 8-item set.

Prior to conducting the EFA on the RPBL Cognitive Processes component, screening analyses were performed to ensure compliance with all relevant EFA assumptions. Skewness and kurtosis coefficients indicated no significant departures from normality in the item distributions, based on Kline's (2005) criteria (values below |3.0| for skewness and below |8.0| for kurtosis). Visual examinations of bivariate scatterplots indicated that the relationships between all item score pairs were linear. Using standard (z) scores, no univariate outliers were identified (all z-scores $\leq$ |3.0|), and Mahalanobis distance χ^2 values suggested no significant multivariate outliers at the 0.001 level. Indices of factorability (i.e., the Kaiser-Meyer-Olkin, or KMO, test, and Bartlett's test of sphericity) also indicated that EFA was suitable for use with this score set. With a high case to item ratio of 34.38, the sample used was large enough to yield reliable estimates of correlations among the variables.

The EFA indicated that either a one or a two-factor model would be tenable in describing the latent structure of the RPBL Cognitive Processes component. While the parallel analysis suggested retaining only one factor (difference between the second random eigenvalue and the second obtained eigenvalue -.14), the scree plot suggested two factors, with the plot of eigenvalues flattening distinctly beyond two factors. The eigenvalue for the second factor also fell just above Kaiser's eigenvalue greater than one criterion (1.00). Given these results, either a one- or a two-factor model was deemed to be plausible in the EFA, and the CFA on polytechnic B participants was used to compare the one- and two-factor models directly. For the one-factor model, the single extracted factor accounted for 56.82% of the total item variance. For the two factor model, together, the two factors obtained accounted for 67.37% of the total item variance (54.85 and 12.52% for factors 1 and 2, respectively).

Communalities and oblique-rotated factor loadings obtained in the EFA based on the two-factor model are shown in Table 3. Based on the pattern coefficients, item loadings across the two factors were consistent with the proposal that the Cognitive Processes component of the RPBL instrument measured readiness for two different aspects of PBL environments: problem-solving and critical thinking. Despite the fact that the parallel analysis suggested that only one factor be retained, as indicated in Table 3, the factor-item loadings indicate that each item loaded strongly on one of the two factors, with minimal cross-loadings on the other factor. All RPBL_PS items loaded into one factor, while RPBL_CT items loaded into another. The Cronbach αs for the Problem-Solving and Critical Thinking subscales were also high at 0.85 and 0.81, respectively.

Given that either a one- or two-factor model could be justified from the EFA, however, both models were tested in the CFA performed on data from polytechnic B (n = 227). The first was based on the original two-factor structure specified, in which the eight RPBL Cognitive Processes items measured students' readiness for two aspects of PBL (problem-solving and critical thinking). Given the results of the parallel analysis obtained for the EFA, however, a second one-factor model was also performed, in which all eight items from this RPBL component contributed to a single factor. The change in χ^2 between the two models was then used to evaluate whether the fit of the two models differed significantly. Again, prior to this analysis, data screening analyses were performed to ensure that all relevant assumptions for CFA in terms of normality, linearity, factorability, and the absence of outlying univariate scores/multivariate score sets were met.

Table 3. Rotated factor loadings for items within the Cognitive Processes component of the RPBL instrument (polytechnic A, *n*=275)

Item	Communalities		Structure Matrix		Pattern Matrix	
	Initial	Extraction	Factor 1: Problem-Solving	Factor 2: Critical Thinking	Factor 1: Problem-Solving	Factor 2: Critical Thinking
RPBL_PS3	0.61	0.72	0.85	0.62	0.82	0.04
RPBL_PS1	0.53	0.62	0.79	0.54	0.82	-0.05
RPBL_PS2	0.46	0.53	0.73	0.51	0.74	-0.02
RPBL_PS4	0.48	0.52	0.71	0.58	0.58	0.19
RPBL_CT2	0.58	0.71	0.64	0.84	0.09	0.78
RPBL_CT3	0.38	0.45	0.43	0.67	-0.10	0.74
RPBL_CT1	0.48	0.55	0.56	0.74	0.07	0.69
RPBL_CT4	0.39	0.42	0.51	0.65	0.11	0.57

These analyses all produced satisfactory results. Given the high case to item ratio of 28.38, the sample size was also deemed large enough to yield reliable correlation estimates.

Despite the results of the parallel analysis obtained from the EFA, the change in χ^2 between the one- and the two-factor models tested was significant, $\Delta\chi^2(1) = 196.34$, $p < 0.05$, indicating that the fit of the original two-factor model was superior to that of the one-factor model. Given this result, the two-factor model was retained for interpretation. Comparing the obtained fit indices obtained with recommended cut-offs for each index (see Hooper, Coughlan & Mullen, 2008), the two-factor model fit the data well. The Goodness of Fit (GFI) and Adjusted Goodness of Fit (AGFI) values were 0.97 and 0.92, respectively, indicating that the proportion of variance accounted for by the estimated population covariance was well within the recommended minimum level (GFI ≥ 0.95 and AGFI ≥ 0.90). The Normed Fit Index (NFI) and Non-Normed Fit Index (NNFI) values for the two factor model (0.94 and 0.94, respectively) fell only marginally below typical recommended levels (i.e. 0.95, or improvement of fit by 95% relative to the null model). Values obtained for the Root Mean Square Error of Approximation (RSMEA), indicating the square-root of the difference between the residuals of the sample covariance matrix and the hypothesized model, and for the Standardized Root Mean Square Residual (SRMR), indicating the standardized difference between the observed correlations and the predicted correlation values, were 0.08 and 0.04, which also fell well within recommended levels (< 0.08 for both). The Comparative Fit Index (CFI) of 0.99 was also well within recommended levels (≥ 0.95). Based on these results and those from the EFA, the internal structure of items within the cognitive processes component of the RPBL based on a two-factor structure appeared to be sound.

RPBL – Learning Processes Component

Again, an EFA was used to obtain a preliminary assessment of the internal structure of the RPBL Learning Processes component, based on a ML extraction procedure with Direct Oblimin rotation. Again, preliminary data screenings indicated no notable deviations from EFA assumptions within this dataset, suggesting that the use of this approach was tenable for these data. The initial EFA indicated three factors within this component of the RPBL, based on the scree plot and Kaisers' eigenvalues greater than one criterion. An examination of the item loadings produced by this EFA indicated that one item (RPBL_SDL3: "In the classroom, I expect the teacher to tell us exactly what we are expected to do" vs. "I usually do not need to be told exactly what is expected of me") did not load together with any other items, forming a third factor in itself. The initial communality for this item was also low (0.11). Following the removal of RPBL_SDL3, the EFA indicated two distinct factors based on the scree plot, Kaiser's criterion, and the parallel analysis (-0.29 between the obtained and randomly generated eigenvalues for the third factor). These accounted respectively for 31.16 and 22.44% of the total item variance (53.60% collectively).

Communalities and oblique-rotated loadings for the RPBL Learning Processes

Component are shown in Table 4. Based on the pattern matrix, the item loadings across the two factors were consistent with the proposal that the items measured two learning processes associated with PBL environments: self-directed and collaborative learning. The Cronbach's α for the self-directed learning subscale (RPBL_SDL) was 0.58, while for the collaborative learning subscale (RPBL_CL), it was 0.65. Thus, the internal consistencies for this component of the RPBL were somewhat lower than for the Cognitive Processes component. This result suggests that these two subscales were factorially more complex than were the two Cognitive Processes subscales. The results of the EFA, however, aligned well with the proposed structure of the RPBL Learning Processes component.

Table 4. Communalities and rotated factor loadings for items within the Learning Processes component of the RPBL instrument (polytechnic A, *n*=275)

Item	Communalities		Structure Matrix		Pattern Matrix	
	Initial	Extraction	Factor 1: Collaborative Learning	Factor 2: Self-Directed Learning	Factor 1: Collaborative Learning	Factor 2: Self-Directed Learning
RPBL_CL2	0.31	0.73	0.77	-0.18	0.86	-0.37
RPBL_CL1	0.27	0.36	0.59	-0.26	0.55	0.14
RPBL_CL3	0.17	0.21	0.46	0.16	0.45	0.06
RPBL_CL4	0.26	0.37	0.51	0.42	0.44	0.33
RPBL_SDL2	0.21	0.35	0.15	0.59	0.03	0.59
RPBL_SDL1	0.19	0.3	0.12	0.54	0.01	0.54
RPBL_SDL4	0.18	0.29	0.1	0.53	-0.02	0.54

Given the results of the EFA on polytechnic A, for the CFA on scores from polytechnic B, the model tested for the RPBL Learning Processes component excluded one of the four SDL items (RPBL_SDL3), leaving a total of seven items within this component. The initial CFA on scores for polytechnic B indicated that the two-factor model proposed did not fit the data well, based on accepted cut-points for CFA fit indices (see Hooper, Coughlan & Mullen, 2008). The overall chi-square obtained for the initial model was $\chi^2(13) = 96.59, p < .05$ ($\chi^2/df = 7.43$). The GFI and AGFI values were 0.89 and 0.77, respectively, which fell below recommended minimum levels (GFI ≥ 0.95 and AGFI ≥ 0.90). The NFI and NNFI values (0.78 and 0.67, respectively) also fell short of recommended levels (≥ 0.95 for both), as did the RSMEA and SRMR values (obtained values 0.17 and 0.14, with recommended levels of 0.08), and the CFI value (0.80). Based on the modification indices obtained, paths were then added between the latent factor RPBL_SDL and two items from the RPBL_CL subscale (RPBL_CL2 and RPBL_CL4). With this modification made, the model fit to the data was excellent, with $\chi^2(13) = 26.06, p < .05$ ($\chi^2/df = 2.37$), NFI/NNFI = 0.94, GFI = 0.97, AGFI = 0.92, RSMEA = 0.08, SRMR = 0.04, and CFI = 0.97. Based on these results, while the CFA supported the internal structure of the RPBL Learning Processes component, it was clear that two items from the RPBL_CL subscale did exhibit significant cross-loadings with the RPBL_SDL subscale.

DISCUSSION

Despite evidence to suggest that students' readiness to engage with various types of learning environments is an important predictor of their learning outcomes, there remains a scarcity of validated instruments which focus on assessing students' readiness to engage in PBL contexts to date. Results of this preliminary evaluation suggest that the RPBL instrument developed may serve to address this gap. These results indicated that the internal structure of the Cognitive Processes component of the RPBL was aligned with the proposed theoretical structure. Loadings from the EFA performed on polytechnic A data indicated that each item from this component loaded strongly upon its respective proposed factor, and minimally with the other factor. Internal consistencies from this sample for both subscales were also high. The CFA using data from polytechnic B also supported the internal structure of this component, indicating excellent fit of the proposed two-factor model to the item data.

The evaluation of the internal structure of the Learning Processes component was also generally favourable. Initially, loadings from the EFA performed on polytechnic A student data indicated one item within the RPBL_SDL subscale that did not load with any other items in that factor. Following removal of this item, all other items loaded strongly upon their respective proposed factors, and minimally with the other factor within the component. Internal consistencies for this sample, however, were relatively low, both for the collaborative learning subscale (RPBL_CL, 0.65) and for the self-directed learning subscale (RPBL_SDL, 0.58). These results suggest that the items within each of the subscales were not entirely consistent in what they measured. Furthermore, the initial CFA using data from polytechnic B did not fit the data well. The fit was excellent, however, when two items from the collaborative learning subscale (RPBL_CL) were allowed to cross-load with the self-directed learning subscale (RPBL_SDL). Thus, while the results broadly supported the internal structure of this component of the RPBL instrument, revisions of the items within the Learning Processes component could enhance the performance of these subscales further. This represents a potential avenue for further research on the instrument.

The evaluation of the RPBL presented in this paper focused only on the internal structure of the instrument. Based on Messick's framework of validity assessment (Messick, 1995) and published AERA, APA, and NCME guidelines, various further steps can be incorporated to "function as a general validity criteria or standards for all educational and psychological measurement" (Messick, 1995, p. 741). Thus, whilst the internal structure of the RPBL instrument was evaluated in this study, future research is needed to provide evidence of its construct validity based on: (i) the test content (e.g., having the instrument reviewed by a panel of experts in the field of PBL); (ii) participants' response processes (e.g. conducting "think aloud" protocols while respondents are completing the instrument); (iii) relationships between the instrument and other, theoretically related variables (e.g., convergent, discriminant and criterion-related correlational validity studies); and (iv) the consequences of using the instrument in 'real world' settings (e.g., exploring positive and negative consequences that result from using the instrument in practice). All of these studies were beyond the scope of the research reported here. Such studies can be conducted in the longer term, to establish whether the use of the RPBL instrument does indeed provide data that institutions can use to enhance students' experiences within PBL environments.

CONCLUSIONS

With many institutions in Singapore now making use of PBL, it is important for students' readiness for these environments to

be assessed. Efforts to achieve this goal may, however, be hampered by a scarcity of suitable instruments for this purpose. The results of the present study suggest that, while further validation efforts would be beneficial, the RPBL holds considerable promise for meeting this important need.

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Efficacy Verification of Team Learning Satisfaction, Problem Solving Ability, and Communication Ability of Problem Solving Process Classes Applying Action Learning, Problem-Based Learning, and Mentoring

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The purpose of this study was i) to design a teaching and learning model for problem solving ability class to which action learning (AL), problem-based learning (PBL), and Mentoring are applied, ii) implement the model to verify the effects of AL's on team learning, iii) analyze the enhancement of problem solving ability through PBL and iv) review development of communication skills through mentoring. The effect of team learning, improvement of problem solving ability within PBL, and improvement in communication through mentoring was verified through comparison of results from quantitative pre- and post-tests. Data was collected two times in the form of a questionnaire for 62 students at the beginning and at the end of the first semester of 2020. A paired samples t-test was among the methods of average comparison on the SPSS 18.0, used to determine differences in team learning satisfaction, problem solving ability, and communication skills based on experiences in AL, PBL, and Mentoring. The results of the test verified the efficacy of PSP class to which AL, PBL, and Mentoring were applied.

Keywords: Action Learning; Problem-Based Learning; Mentoring; Problem Solving Process

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INTRODUCTION

The World Economic Forum (WEF) in 2017 publicized ten skills required to thrive in the Fourth Industrial Revolution: (1) Complex Problem Solving, (2) Critical Thinking, (3) Creativity, (4) People Management, (5) Coordinating with Others, (6) Emotional Intelligence, (7) Judgment and Decision Making, (8) Service Orientation, (9) Negotiation, and (10) Cognitive Flexibility. A competent, talented person for the 21st century can be one who not only possesses a wide range of knowledge but also accepts new knowledge, applies it to problem solving, and carries out roles and functions as a member of society. Given the WEF's list of skills, vocational colleges in the provinces in Korea, in particular, should develop a variety of teaching methods; consideration needs to be given to the significance of nurturing talent, as well as seeking improvement in adaptability, problem-solving ability, communication skills, and interpersonal ability. In these abilities there is a perceived deterioration in student levels of ability.

This researcher has been conducting problem solving process (PSP) classes since 2016 in line with the trend of the times and the goal of cultivating talent in college students. The PSP class consists of AL, PBL, and Mentoring. Here, AL is a method where learning occurs

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through a process to derive a solution to a task. PBL is a method in which learners jointly discuss problem-solving methods and then prepare a common solution through both individual and cooperative learning processes. Mentoring is a way to improve a mentee's skills and potential with the guidance and advice of a mentor.

The purpose of this study was i) to design a teaching and learning model for PSP class to which action learning (AL), problem-based learning (PBL), and Mentoring are applied, ii) implement the model to verify the effects of AL's on team learning, iii) analyze the enhancement of problem solving ability through PBL and iv) review development of communication skills through Mentoring. Quantitative tests were applied with the aim of presenting directions for teaching and learning that can effectively respond to the college's quest to contribute to a knowledge-based society.

The research hypotheses used in this study were as follows:

1) Verification of the significance of responses to the question: "Does AL change learners' satisfaction with team learning?" AL is a method of education and training in which teams are formed to solve problems. Therefore, this paper mainly studies the effect on learning among team members through collaboration.

Hypothesis: AL education is effective in increasing learners' satisfaction with team learning.

2) Verification of the significance of responses to the question: "Does PBL change learners' problem solving ability?" Hypothesis: PBL education is effective in increasing learner's problem solving ability.

3) Verification of the significance of responses to the question: "Does Mentoring change learners' communication skills?" Mentoring involves mentors who give advice and mentees who receive advice. Therefore, in this paper, the effect of communication between mentor and mentee is central to perceived outcomes.

Hypothesis: Mentoring education is effective in improving learners' communication skills.

4) Verification of the significance of responses to the question: "Does Mentoring improve mentors' satisfaction with their college life?"

LITERATURE REVIEW

Theoretical Review: This section examines a selection of concepts within previous studies on the effects of team learning satisfaction, problem solving ability improvement, and communication skills, the variables within the PSP classroom approach.

1) Team learning

Team-based learning (TBL), first introduced by Larry Michaelsen, a professor at Oklahoma University in the 1970s, is a special teaching strategy in which simple small groups are converted into teams for optimal performance (Michaelsen, 2009). The TBL instructors are designers and managers of overall curriculum, serving as a manager of knowledge (Shin, 2019). TBL can have positive effects on learner's motivation, learning attitude, participation, communication skills, academic achievement, self-directed learning, academic self-efficacy, emotional intelligence, and satisfaction (Kim Yun Kyung, Kim Nuri, 2015; Lee Kyung Hee, Son Eun Kyung, 2012; Ha Chae Yeon, Lee Soo Young, 2014). According to these studies, TBL affects attitudes to learning and satisfaction of learners on a relatively consistent basis. This study aims to examine team participation, reliability between team members, team learning satisfaction, and team learning effectiveness through TBL.

2) Problem solving ability

Problem solving ability is an intellectual and creative process of quickly and effectively resolving differences between the current state and the target to be achieved by a problem solver (Kahney, 1986). Solving a problem requires a goal achievement, a process of change in thinking and behavior to achieve the goal (Lee et al., 2003;Park, 2017). In the mid to late 1900s researchers of cognitive theory regarded problem solving ability and creativity as the same cognitive phenomenon (Guilford, 1967) or viewed creativity as a form of problem solving (Mumford, et al., 1991). Originality, flexibility, and fluency of creativity are generally regarded to be inseparable from problem solving ability; the two concepts of problem solving ability and creativity were combined into one complex concept, called Creative Problem Solving (CPS) (Feldhusen & Treffinger, 1985). To analyze problem solving ability, this study examined orientation of problems, analysis of problem causes, deduction and verification of solutions, practicability of solutions, and verification and evaluation of practice.

3) Communication skills

A mentor and mentee are involved in mentoring; communication skills between the two is very important. Carkhuff (1972) cited empathy, respect, warm expressions, specificity of expression, genuineness, self-disclosure, confrontation, and immediacy as factors communication skills (as cited in Ryu, 2014). According toLee et al., (2003), the components of communication skills include (1) interpreting dialogue from collecting information about and listening to them, (2) playing a role by overcoming stereotypical thinking and communicating creatively and with

open-mindedness, (3) expressing their own thoughts without pretension, (4) setting goals to lead communication in which one presents one's own opinions clearly, and (5) converting messages to understand the words and stance of the other person (Shin, 2014). This study examined listening, sincerity, the positive nature of expression, consideration and understanding, and satisfaction with college life, in order to analyze the appropriateness of communication skills.

Communication of Teaching Methods: Previous studies on AL, PBL, and Mentoring, highlighted the relationships among components of teaching and learning models of PSL class.

1) AL - consists of six components: a task to be solved, a constituent learning team, a reflection on learning effects and a set of questions mutually agreed upon by learners, a willingness to practice, an approach to learning through task solving, and involvement of a learning coach (Marquardt, 1999). To experience successful learning in AL, all criteria should be satisfied (Kim & Um, 2014, 2011).

Table 1, shows how participation in the six components of action-oriented learning has the potential to lead to solutions to problems posed by a team (or organization), in this case, through the action learning process proposed by Lee (2018).

2) PBL has been the focus of scholars for decades. PBL is, according to Barrows & Tamblyn (1980), i) learning from processes and activities for understanding or solving problems, or ii) a method of learning or teaching in which problematic situations are used for students to actively participate in learning processes. Albanese & Mitchell (1993) defined PBL as a teaching method in which problems are used to teach students problem solving ability and basic knowledge. Gallagher & Stepien (1996) reported that PBL is a cyclical process of defining a problem, selecting hypotheses for learning, and detecting concrete learning problems. Cho Yeon Sun (2006) defined PBL as an educational approach in which learners are led to learn the necessary knowledge by themselves through processes of problem solving from real-world, non-structured problems (Kim, 2010).

3) Mentoring - Park Sung Mi (2006), using psycho-social, career-development, role-modeling, friendship protection as a criterion-related mentoring function scale, reported development and validation of tools to measure Mentoring functions for college students. Kim Ji Eung (2008) dealt with the effects of college students' Mentoring functions on adaptation to and satisfaction with college life (Kim, 2010).

Table 1. AL processes presented in previous studies

Division	O'Neil & Marsick (2007/2014)
Clarification and cause analysis of tasks	1. Checking tasks
	2. Drawing and verifying hypotheses
	3. Drawing necessary items
	4. Collecting data and benchmarking
Drawing solutions for tasks	5. Developing ideas for solution
	6. Decision making
Practicing task solutions	7. Authorization and participation
	8. Practicing
Reflection and evaluation	9. Evaluating performance
	10. Feedback

METHODS

This paper has received IRB approval from Suncheon Jeil College Industry-Academy Cooperation Foundation (IACF) (Approval number: IACF-2020-1).

Table 2 shows the group of study subjects divided into mentors and mentees.

Figure 1 shows the conceptual model used in the study; N = 62 subjects - mentors and mentees

Figure 2 shows the approach to this study and the flow of the teaching and learning method. This study began at the end of 2019 and consists of the steps of development of an APM teaching and learning model, modification and supplementation of the model, model application, results analysis.

In this study, 65 freshmen majoring in electrical engineering at Suncheon Jeil College who took the PSP class were divided into three groups A, B and C according to their Student Number. Three were excluded due to military enlistment; 62 students

Table 2. Subject groups and mentors and mentees (Unit: Persons, %)

Groups	Freshmen						Total	
	A		B		C			
Experimental groups	21		21		20		62 (persons)	
	33.9		33.9		32.2		100 (%)	
Subject groups	Mentors	Mentees	Mentors	Mentees	Mentors	Mentees	Mentors	Mentees
	4	17	4	17	4	16	12 (persons)	50 (persons)
	19.1	80.9	19.1	80.9	20	80	19.4 (%)	80.6 (%)

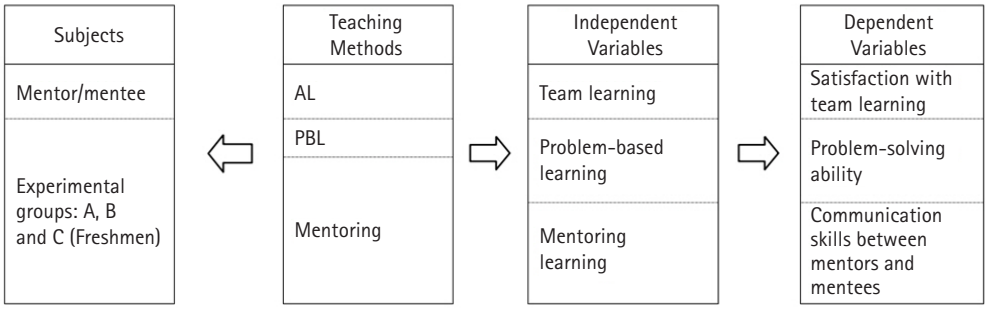

Figure 1. Conceptual model of study.

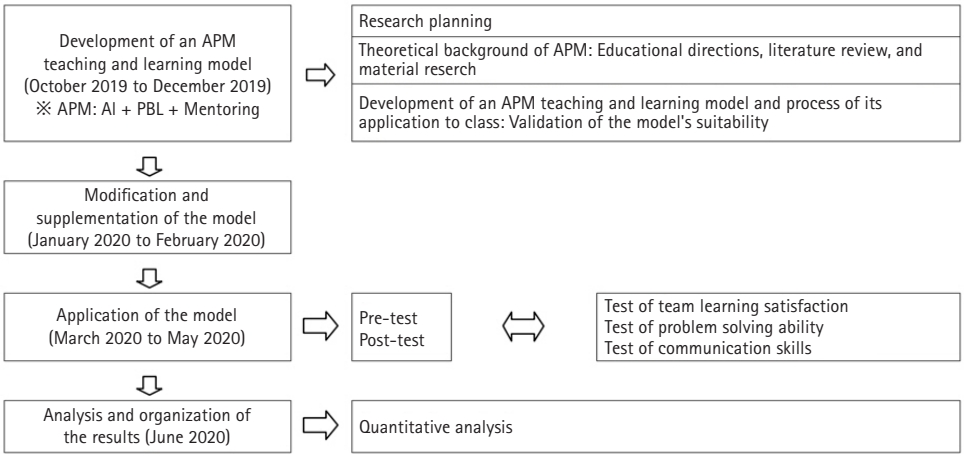

Figure 2. Research model and flow of teaching and learning.

were surveyed. Of the 62 students taking PSP classes, 1 female and 61 males - 12 were Mentors (19.4%) and 50 Mentees (80.6%).

The following test tools were used to determine team learning satisfaction, problem solving ability, and the nature of communication skills.

1) Team learning satisfaction

This study modified and supplemented the tool for learning satisfaction revised by Kim Yeon Soon (2013) to measure learner's satisfaction with team learning. The sub-elements included the following items - two for team participation, two for reliability among team members, three for team learning satisfaction, and five for team learning effectiveness. For responses to 12 questions, a five-point Likert scale was used - 1 indicating negative to 5 positive.

2) Problem solving ability

To measure the problem solving ability of learners, the tool used, focused on college students and adults, one of the life-competencies measurement tools developed by the Korean Educational Development Institute (KEDI) (Lee et al., 2003). The sub-elements included three items for orientation of problems, two for analysis of problem causes, three for deduction and verification of solutions, two for practicability of solutions, and two for verification and evaluation of practice. A five-point Likert scale was applied to 12 questions, from 1 point as negative to 5 points - positive.

3) Communication skills

This researcher reorganized the tool for measuring communication skills of college students and adults, one of the life-competencies measurement tools developed by the KEDI (Lee et al., 2003). The sub-elements included four items for listening, two for sincerity, three for positivity of expression, and three for consideration and understanding. Responses to 12 questions were based on a five-point Likert scale (1 indicating negative and 5 positive).

DESIGN AND PROCEDURES

1) Experimental design

A quantitative explanatory design involved comparison between pre- and post surveys of perceptions of 62 freshmen who

took the PSP class; 12 mentors and 50 mentees participated. A control group was not used. The first survey immediately after forming teams with mentors at Week 1 and the second in Week 14 at the end of the course. The questionnaire consisted of 12 questions for team learning satisfaction, 12 for problem solving ability, and 12 for communication skills.

2) Experimental procedures

Figure 3 illustrates the experimental process from mentor selection to school termination. Completion of service was the criterion for mentor selection of 12 students. Mentors with military service were deemed credible among their classmates, had a strong spirit of service, could establish smooth relationships and were interested in mentoring their peers. The mentor's main role was to listen to mentee's concerns and provide psychological support and academic support.

3) PSP class content

Table 3 shows PSP lectures conducted weekly, attended by both mentors and mentees. Hourly classes were held for 15 weeks.

ANALYSIS

The first of 2 surveys included all the original 65 subjects; Week 14 involved 62 as 3 took leave due to military service enlistment. Their surveys were excluded from the data. Comparisons across the identical surveys showed perceptions of the effects of AL, PBL, and Mentoring on the learning experience. SPSS 18.0 was used to input and analyze the data. A paired sample t-test among was used to determine differences in perceptions about team learning satisfaction, problem solving ability, and communication skills, based on experiences in AL, PBL, and Mentoring.

RESULTS

Pre-and post-surveys provided insight into student perceptions of their experiences with a PSP class to which AL, PBL, and Mentoring were applied. Comparison between the baseline and summative data verified the effects of team learning within AL and improvements in problem solving ability and communication skills.

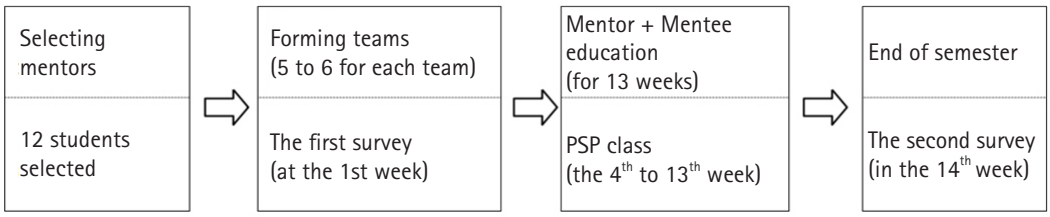

Figure 3. Flow of problem solving process class.

Table 3. Problem solving process class content per week

	Schedule	Topic	Main Content
APM	The 1st to 3rd week	Understanding of AL, PBL, and Mentoring	• Personal communication skills
			• Team communication skills (how to improve team dynamics)
			• How to run a team meeting
	The 4th to 6th week	PBL-type task execution	• How to select tasks
			• Understanding models of task performance
			• Learning task definition steps
	The 7th to 11th week		• Learning task research steps
			• Learning steps of deduction and validation of solutions
			• Learning steps of preparing action plans
	The 12th to 13rd week	PBL comprehensive practice	• Practicing step-by-step team roles (actual activities by teams)
			• Mutual feedback
	The 14th to 15th week	PBL follow-up	• Sharing experiences of practice
			• Identifying difficulties and mutual feedback
			• Skill-up for improving team learning competency

1) Effects of AL on team learning satisfaction

To analyze statistical differences in team learning satisfaction based on AL experiences, paired sample t-tests were applied, with two items for team participation, two for reliability between team members, three for team learning satisfaction, and five for team learning effectiveness on the Likert 5-point scale. In this study, "AL education" was selected as an independent variable, and team participation, reliability between team members, team learning satisfaction, and team learning effectiveness at the beginning and the end of the semester were selected as verification variables for analysis. To interpret and determine the results, a null hypothesis "AL education is not effective on increasing learners' satisfaction with team learning" and a research hypothesis "AL education is effective on increasing learners' satisfaction with team learning" were used.

The analysis methods used in Table 4 and 5, Table 6 and 7, Table 8 and 9 show paired t-tests. This analytical method measuring one sample twice (pre-post measurement), determines any difference between the two measurements. Table 4, Table 6, and Table 8 are 'paired sample statistics and analyze the difference in satisfaction between results at the beginning and the end of the semester. Table 5, Table 7, and Table 9 are 'paired sample tests' to determine whether the study hypothesis is rejected given the significance level.

Table 4 shows the results of analyses at the beginning and the end of the semester for evaluating team learning satisfaction based on AL experiences. The number of samples (N) is 62, and average means the average satisfaction based on AL experiences. In all the verification variables, the averages remarkably increased at the end of the semester in comparison to the beginning; for 'Team participation', the average increased from 1.66 (low satisfaction) at the beginning to 4.21 (high) at the end.

Table 5 shows the results of analyzing test differences in the paired samples used at the beginning and end of the semester to evaluate team learning satisfaction based on AL experiences. When the significance levels were analyzed, the absolute value of the t-value was from 22.774 (min.) up to 36.421 (max.), which exceeded 1.96, for all the verification variables. The significance

Table 4. Differences in statistics of team learning satisfaction based on action learning experiences

Statistics of paired samples						Correlation coefficients of paired samples		
		Average	N	Standard deviation	Standard error of average		Correlation coefficients	Significance probability
Team participation	Beginning of semester	1.66	62	0.651	0.083	Beginning & end of semester	0.215	0.093
	End of semester	4.21	62	0.750	0.095			
Reliability between team members	Beginning of semester	1.35	62	0.630	0.080	Beginning & end of semester	0.094	0.466
	End of semester	4.66	62	0.676	0.086			
Team learning satisfaction	Beginning of semester	1.71	62	0.555	0.070	Beginning & end of semester	-0.038	0.772
	End of semester	4.35	62	0.482	0.061			
Team learning effectiveness	Beginning of semester	1.39	62	0.523	0.066	Beginning & end of semester	-0.037	0.776
	End of semester	4.77	62	0.493	0.063			

Table 5. Test differences in paired samples of team learning satisfaction based on action learning experiences

Test of paired samples									
		Paired differences					t	Degree of freedom	Significance probability (both)
		Average	Standard deviation	Standard error of average	95% confidence interval of difference				
					Lowest	Highest			
Team participation	Beginning to end of semester	-2.548	0.881	0.112	-2.772	-2.325	-22.774	61	.000
Reliability between team members	Beginning to end of semester	-3.306	0.879	0.112	-3.53	-3.083	-29.604	61	.000
Team learning satisfaction	Beginning to end of semester	-2.645	0.749	0.095	-2.835	-2.455	-27.819	61	.000
Team learning effectiveness	Beginning to end of semester	-3.387	0.732	0.093	-3.573	-3.201	-36.421	61	.000

probability (for both) was 0.000. Thus, it is reasonable to consider that the research hypothesis is supported. The significance probability is between 0 and 1, and if the significance level is less than 0.05, the research hypothesis is adopted with a probability of 95%.

2) Effects of PBL on problem solving ability

To analyze statistical differences in problem solving ability

Table 6. Differences in statistics of problem solving ability based on problem-based learning experiences

Statistics of paired samples						Correlation coefficients of paired samples		
		Average	N	Standard deviation	Standard error of average		Correlation coefficients	Significance probability
Orientation of problems	Beginning of semester	1.66	62	0.626	0.079	Beginning & end of semester	0.023	0.859
	End of semester	4.69	62	0.642	0.082			
Analysis of problems' causes	Beginning of semester	1.48	62	0.62	0.079	Beginning & end of semester	-0.090	0.486
	End of semester	4.35	62	0.482	0.061			
Deduction and verification of solutions	Beginning of semester	1.82	62	0.529	0.067	Beginning & end of semester	-0.093	0.471
	End of semester	4.77	62	0.493	0.063			
Practicability of solutions	Beginning of semester	1.6	62	0.664	0.084	Beginning & end of semester	-0.001	0.991
	End of semester	4.92	62	0.275	0.035			
Verification and evaluation of practice	Beginning of semester	1.53	62	0.646	0.082	Beginning & end of semester	0.059	0.648
	End of semester	4.73	62	0.45	0.057			

Table 7. Differences in paired-samples test of problem solving ability based on problem-based learning experiences

Test of paired samples									
		Paired differences					t	Degree of freedom	Significance probability (both)
		Average	Standard deviation	Standard error of average	95% confidence interval of difference				
					Lowest	Highest			
Orientation of problems	Beginning to end of semester	-3.032	0.886	0.113	-3.257	-2.807	-26.934	61	.000
Analysis of problems' causes	Beginning to end of semester	-2.871	0.82	0.104	-3.079	-2.663	-27.585	61	.000
Deduction and verification of solutions	Beginning to end of semester	-2.952	0.756	0.096	-3.144	-2.760	-30.746	61	.000
Practicability of solutions	Beginning to end of semester	-3.323	0.719	0.091	-3.505	-3.140	-36.379	61	.000
Verification and evaluation of practice	Beginning to end of semester	-3.194	0.765	0.097	-3.388	-2.999	-32.880	61	.000

Table 8. Differences in statistics of communication skills based on Mentoring experiences

Statistics of paired samples								
		Average	N	Standard deviation	Standard error of average		Correlation coefficients	Significance probability
Listening	Beginning of semester	1.68	62	0.647	0.082	Beginning & end of semester	0.077	0.550
	End of semester	4.16	62	0.729	0.093			
Sincerity	Beginning of semester	1.5	62	0.647	0.082	Beginning & end of semester	-0.037	0.774
	End of semester	4.65	62	0.680	0.086			
Positiveness of expression	Beginning of semester	2.23	62	2.614	0.332	Beginning & end of semester	-0.078	0.549
	End of semester	4.35	62	0.482	0.061			
Consideration and understanding	Beginning of semester	1.6	62	0.664	0.084	Beginning & end of semester	-0.182	0.156
	End of semester	4.77	62	0.493	0.063			

Table 9. Differences in paired samples test of communication skills based on Mentoring experiences

Test of paired samples									
		Paired differences					t	Degree of freedom	Significance probability (both)
		Average	Standard deviation	Standard error of average	95% confidence interval of difference				
					Lowest	Lowest			
Listening	Beginning to end of semester	-2.484	0.936	0.119	-2.722	-2.246	-20.887	61	.000
Sincerity	Beginning to end of semester	-3.145	0.956	0.121	-3.388	-2.903	-25.918	61	.000
Positiveness of expression	Beginning to end of semester	-2.129	2.695	0.342	-2.813	-1.445	-6.221	61	.000
Consideration and understanding	Beginning to end of semester	-3.177	0.897	0.114	-3.405	-2.950	-27.901	61	.000

based on PBL experiences, this study conducted a paired sample t-test before and after the educational event, with three items for orientation of problems, two for analysis of problems' causes, three for deduction and verification of solutions, two for practicability of solutions, and two items for verification and evaluation of practice.

In this study, "PBL education" was selected as an independent variable, and orientation of problems, analysis of problems' causes, deduction and verification of solutions, practicability of solutions, and verification and evaluation of practice at the beginning and the end of the semester were selected as verification variables for analysis. To interpret and determine the results, a null hypothesis "PBL education is not effective on increasing learner's problem-solving ability" and a research hypothesis "PBL education is effective on increasing learner's problem-solving ability" were used. According to the definition of Gallagher & Stepien (1996), PBL is a cyclical process of defining a problem in a problem situation, setting hypotheses necessary for learning, and finding specific learning problems. Therefore, we needed to verify student problem solving ability after learning with PBL methods.

Table 6 shows the results of analysis at the beginning and end of semester to evaluate satisfaction with problem solving ability based on PBL experiences. Average means the average satisfaction based on PBL experiences. In all the verification variables, the averages remarkably increased at the end of the semester in comparison to the beginning; for orientation of problems, the average increased from 1.66 at the beginning to 4.69 at the end.

Table 7 shows the results of analyzing test differences in paired samples used at the beginning and the end of the semester to evaluate problem solving ability based on PBL experiences. When the significance levels were analyzed, the absolute value of the t-value was from 26.934 (min.) up to 36.379 (max.), which exceeded 1.96, for all the verification variables. The significance probability (for both) was 0.000. Thus, it is reasonable to consider that the research hypothesis is supported.

3) Effects of Mentoring on communication skills

To analyze statistical differences in communication skills based on Mentoring experiences, a paired sample t-test before and after the educational initiative was undertaken, with four items for listening, two for sincerity, three for positivity in expression, and three for consideration and understanding.

"Mentoring" was selected as an independent variable, and listening, sincerity, positivity of expression, and consideration and understanding at the beginning and end of semester were selected as verification variables for analysis. To interpret and determine the results, a null hypothesis "Mentoring education is not effective on improving learners' communication skills" and a research hypothesis "Mentoring education is effective on improving learners' communication skills" were used.

Table 8 shows the results of correspondence analysis at the beginning and end of semester for evaluating satisfaction with communication skills based on Mentoring experiences. Average means the average satisfaction based on Mentoring experiences. In all the verification variables, the averages remarkably increased at the end of the semester in comparison to the beginning; for listening, the average increased from 1.66 at the beginning to 4.16 at the end.

Table 9 shows the results of analyzing test differences in paired samples used at the beginning and the end of semester to evaluate communication skills based on Mentoring experiences. When the significance levels were analyzed, the absolute value of the t-value was from 6.221 (min.) up to 27.901 (max.), which exceeded 1.96, for all the verification variables. The significance probability (both) was 0.000. Thus, it is reasonable to consider that the research hypothesis is supported.

4) Effects of Mentoring on improvement in Mentors' satisfaction with college life

The mentors generally showed high satisfaction with Mentoring (4.58 to 4.92), probably because they were systematically educated and a variety of programs were provided to create rapport

Table 10. Effects of Mentoring on satisfaction with college life (at the end of the semester)

		Statistics						
		General satisfaction	Satisfaction with methods used	Satisfaction with mentor roles	Active participation	Satisfaction during Mentoring	Willing to invite others	Improvement in adaptation of mentees
N	Valid	12	12	12	12	12	12	12
	Missing	0	0	0	0	0	0	0
Average		4.83	4.92	4.92	4.92	4.58	4.92	4.83
Standard deviation		0.389	0.289	0.289	0.289	0.515	0.289	0.389
Variation		0.152	0.083	0.083	0.083	0.265	0.083	0.152
Sum		58	59	59	59	55	59	58

between mentors and mentees. The various programs referred to here refer to the peer mentoring training courses conducted by the Suncheon Jeil College Student Counseling Center, including weekly PSP classes in Table 3. The peer mentoring training course consists of the basic attitude of conversation, helpful conversation, knowing the type of learning personality, and knowing the learning type of mentee.

The average shown in Table 10 is obtained by the satisfaction of mentoring activities to 12 mentors.

DISCUSSION

This study aimed to i) design a teaching and learning model of PSP class to which AL, PBL, and Mentoring were applied, and ii) implement the model to verify the effects of AL on team learning and identify improvements in problem solving ability through PBL and communication skills through Mentoring by conducting quantitative tests.

The statistical significance of the research results are as follows.

First, based on the significance of the research hypothesis, AL was proven to have effects of positively changing students' team learning satisfaction. When the significance level was analyzed, the absolute value of the t-value exceeded 1.96 in all the verification variables. The average satisfaction considerably increased from 2.548 (min.) at the beginning to 3.387 (max.) at the end of the semester.

Second, based on the significance of the research hypothesis, PBL was verified to have effects of positively changing learners' problem solving ability. When the significance level was analyzed, the absolute value of the t-value was from 26.934 (min.) to 36.379 (max.), which exceeded 1.96, and the significance probability (both) was 0.000. As for orientation of problems, the average considerably increased from 1.66 at the beginning to 4.69 at the end of the semester.

Third, based on the significance of the research hypothesis, Mentoring was verified to have effects of positively changing learners' communication skills. When the significance level was analyzed, the absolute value of the t-value was from 6.221 (min.) to 27.901 (max.), which exceeded 1.96, and the significance probability (both) was 0.000. As for listening, the average increased from 1.66 at the beginning to 4.16 at the end of the semester.

Fourth, Mentoring had effects of increasing Mentors' satisfactions with college life. The general satisfaction of the Mentors' with Mentoring activities was high, from 4.58 (min.) to 4.92 (max.).

Academic and practical implications

First, this study designed a teaching and learning model to which AL, PBL, and Mentoring were applied. Having implemented the model, analysis was undertaken of the effects of AL on team learning, of PBL on improving problem solving ability, of Mentoring on improving communication skills, and satisfaction of Mentors' with Mentoring activities.

Second, this study conducted a paired sample t-test to analyze the effects of AL, PBL, and Mentoring to prove their significance.

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Exploring Learning Strategies of Nursing Students at Hue University of Medicine and Pharmacy, Vietnam

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Background: Application of appropriate teaching and learning strategies is a necessary way of influencing student learning outcomes. The purpose of this study was to explore students' views, perceptions and the effects of these on different teaching and learning approaches.
Methods: Twenty one nursing students who were exposed to different teaching strategies were selected as a purposive sample for this study. Qualitative analysis of feedback from six individual interviews and two focus groups encompass a rich data set to inform nurse educators about student perceptions regarding impact of teaching approaches on their learning outcomes.
Results: Participants indicated advantages and disadvantages of each of the teaching strategies and recommended suggestions for improving learning outcomes. The findings also described how a student's preferred learning strategy impacted on learning outcomes when criteria for surface, deep and strategic approaches were taken into consideration.Conclusions: This research provides evidence for educators on the effects of innovative teaching and learning strategies in nursing education. It also provides preliminary feedback on the extent of achievements on the movement towards national reforms in higher education.

Keywords: Blended learning strategies; PBL in nursing; Educational reform in Vietnam

Original Article

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INTRODUCTION

Nowadays, Vietnam is pursuing greater levels of international integration and renovation in all fields, including education and training. As it is considered a dynamic country with a young population, Vietnam has seen a significant increase in the number of higher education students compared with the past 20 years. Renovation of higher education systems and processes is an urgent requirement to improve the quality of teaching and learning in Universities (Resolution 29/TW-Vietnamese Communist Party, 2013). To achieve this goal, a lot of policies, strategies and action plans were set up and implemented in the universities with oversight from MOET (Ministry of Education and Training).

Some achievements include developing and perfecting formal documents to improve the quality of education management outcomes; budget increases at the national level for higher education; rapid increases in the number of the public and private universities and the growth in number and quality of teaching staff (MOET, 2018). However, there are still many challenges and limitations. Within survey findings, commentary on Vietnamese teaching and learning methods was as follows:

The method of teaching is not effective, present only and less use of active learning skills. Therefore, there are less interactions between students and teachers inside and outside the

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classroom; too much emphasis on memorizing knowledge without relying on high-level conceptual or academic learning such as analysis and synthesis, as consequence in superficial learning instead of active learning; students learn passively (Ngo, 2010);

…to date, no Vietnamese universities are ranked in the world's top 1,000 universities (based on well-known world university rankings). The regulatory environment is highly bureaucratic and centralized through the Ministry of Education and Training (MOET), which has authority over education, including higher education (Temmerman, 2019).

Hence, innovation to transform higher education in Vietnam is essential to achieve education consistent with countries in the region and across the world. This demands comprehensive procedures including: curriculum reform, accreditation, teacher quality and alternative ways of teaching (Temmerman, 2019). As a consumer of education, the student should be offered ways to change their learning process to adapt to innovation. Currently, many universities in Vietnam have changed and applied more active teaching methods in education, with the aim of achieving student-centered approaches to learning, enhancing creativity and encouraging active participation in learning processes, applying knowledge in practice and being able to solve the real-life problems. Specifically, for the medical and health professions, after graduation, professionals must be able to work and deal well with matters related to human health, thus educational renovation that closely relates to dealing with 'reality' is necessary. In recent years, Hue University of Medicine and Pharmacy (Hue UMP) has applied new methods of teaching and learning in parallel with traditional teaching methods in medical education such as case-study, E-learning, U-learning, problem-based learning (PBL), team based-learning (TBL), and involvement with simulation for learning. As a result, there are many positive changes in teaching and learning processes in Hue UMP (Nguyen et al. 2017).

However, the application of such new methods will affect the student's learning strategies. Many students experienced some "embarrassment with the new method", other students found it "difficult to find reference materials" and reported that "reasonable time allocation to group-work is also an obstacle". In addition, students feel exhausted from a busy study workload that was a consequence of the method that demanded more active learning; students sometimes feel very pressured. Students complained that they spend a lot of time on one subject and that affects other subjects (Tran et al. 2017). Devine and Meagher (1989), decades ago, acknowledged there were many factors which contribute to students' success. The most important were to know how to learn, manage time, read and listen effectively, take effective notes, understand and remember. Learning strategies are "behaviours of a learner that are intended to influence how the learner processes information" (Mayer, R. 1988). It is evident from a number of other studies that study strategies have a positive effect on achievement of goals (Marzano, Pickering & Pollock, 2001; Heath, Ellen &Kaira, 2009).

Therefore, understanding student's learning strategies when applying more active teaching methods is necessary for teachers and students to find the optimal approaches in order to improve student's academic experiences. In addition, this process improvement contributes to maintenance of quality in teaching and learning within the Hue UMP. The purposes of study were to determine nursing students' perception on different teaching and learning strategies; explore student's learning approaches related to various teaching strategies; and describe instructional strategies that promote optimal student learning outcomes.

METHODS

A qualitative descriptive approach was used for this research, that aimed to explore nursing student perspectives on their learning experiences. Six in-depth interviews and two focus groups (6-7 students/group) were conducted using semi-structured interviews with open-ended questions to collect subjective data sets. Observations of learning events and field notes and memos supported data collection and analysis.

Research setting

The research setting in the Hue University of Medicine and Pharmacy in Vietnam provides a variety of nursing programs for both undergraduate and postgraduate (masters) levels. Several teaching and learning approaches involved in nursing education aimed to promote deep learning.

Research participants

The study participants were 21 students receiving different teaching approaches ranging from online to 'in class' strategies including lecture-based, problem-based, U-learning and E-learning within an undergraduate baccalaureate nursing program. A purposive sampling method was used to recruit the participants.

Data collection process

Faculty members developed and implemented several teaching strategies into each nursing module. Following the educational activity, separate evaluation processes were used to assess the effectiveness of the teaching approaches. The researcher conducted and audio-recorded six in-depth interviews and two separate focus group discussions to explore views on experiences of stu-

dents regarding their learning experience. In addition, observations proposed from feedback during focus groups, allowed for further investigation of the responses of students when exposed to the learning setting. The observer recorded students' activities and conversations for analysis. Field notes and memos also contributed to data analysis. Semi structure interviews and focus groups were guided by prompts such as, "Please tell me your experience/ views with teaching and learning strategies used in the nursing educational program"; "Please share your opinions about an effective teaching strategy and your learning process"; "Please tell me about the suggestions for improving effectiveness of teaching and learning strategy".

Data analysis

The recordings of the focus groups were transcribed after the end of the interview sessions. Qualitative content analysis aimed for rich and deep information. The investigator read and reread all data sets. Emerging themes were systematically recorded with data arranged and collated according to categories. The data from observation, field notes and memos were included throughout the analysis. The Atlas.ti 8.0 program was applied for analysis of data on teaching approaches used.

Ethical Issues

Permission for the conduct of the research was received from Hue University of Medicine and Pharmacy, in Vietnam. Throughout the study, ethical principles were applied - the purpose of the study was explained to all the participants and informed consent was obtained for each interview and voice recording and observations. The participants were assured of the confidentiality of the data. In addition, the recorded interviews were kept in a safe place, only accessible by the researchers.

Findings

1. Exploration of perceptions of nursing students toward different teaching-learning methods

Findings indicate students' perceptions are divided into advantages and limitations. Results showed students' perceptions on advantageous aspects of five teaching-learning methods. The benefits of the traditional lecture-based method used for 'fixed resource sessions', were seen as provision of consistent and detailed knowledge, material that was easy to understand and convenient to review, and appropriateness to the study schedule.

"... all knowledge is available in the text-book; I can just look back whenever I need. Besides, through lectures, I can also learn (from the) experience (of) my teachers, It's easier to learn and to understand than reading books or searching information myself ..."

"... with a busy study schedule, the traditional method seems to be more convenient, we spend less time preparing at home… just need to listen to lecture in class and try to remember ..."

"... for the basic subjects, I think traditional teaching method is very suitable because those subject maintain specific content, the definitions and principles are fixed and brief… listening to lectures teaches, (shows how to) analyze problems and gives examples, students will easily understand ..."

Through activities within methods such as PBL, E-learning and U-learning, students reported feeling that these were more convenient, they could be more proactive and creative. They valued visual content, activities helped them improve not only nursing skills and knowledge, but also non-technical skills including communication, leadership, team-work, decision-making, and situation-awareness skills. The participants suggested advantages of PBL methods involved proactivity; these were positive and creative methods leading to deeper learning, increased interaction, increased independence, increased ability to apply learning in clinical practice, develop non-technical skills, and add more knowledge taken out of textbooks.

"... with a given case study, students will actively learn about knowledge, when discussing and exchanging between groups, they should have complete knowledge (to provide) for each other between groups… "

"… making reports, students will read more documents on assigned issues ...",

"… students should also interact (report from other groups), (be) open-minded and receive new things, some information needs teachers to correct and analyze, ones (that are) are beneficial should be applied",

"... when presenting a report, helping me feel more confident, when listening to other groups presenting, if I don't understand, I will confidently ask my friends so I can improve my questioning skills..."

"… my communication skills also increased significantly, I confidently give my opinions and make it clear, in group discussion we usually (have) arguments or conflicts - I know how to calmly resolve (these). And at presentation, I can give my feedback and open-mindedly receive feedbacks from my friends...".

In addition, most participants mentioned the convenience of the approach, stimulating learning processes and improving learning efficiency. Improving independence and being proactive were positive outcomes from e-learning, for example

"... study at home, I can arrange to study at my leisure time, I can study early because the teachers have assigned the lesson first ..."

"...because the phone can be used, students often read it, students have to go to school less often...",

"... videos about techniques, watching videos I know how to do, easier to remember… than reading books… when reading books, I could not imagine, but watching the video I will know how to do this step by step",

"… students are more proactive, increase their independence and learn for themselves ..." For the U-learning approach, the participants again recognized the convenience of the approach, it was visual and easy to understand, it increased their ability to apply ideas in clinical practice, and it was convenient and offered various styles in examinations.

"...everyone has a smartphone, they can connect to the internet and download documents and then learn anywhere, anytime ...",

"...I can see how the symptoms, the signs like, accessible by images, videos, so I can visualize it more easily",

"... while studying, students can compare to real clinical situations, have videos on clinical situations, so the ability to apply in clinical practice is higher ...",

"... I like the way this method works, how to do the exercises on the tablet, without using paper and pen, (teachers) can apply many types to make questions, pictures, videos, richer topic types and know the score immediately after the exam ..."

The results in Table 1 illustrated the student's perceptions about disadvantages related to receiving different teaching strategies. The lecture based-approach posed limitations on long-term memorization and expansion of knowledge, was less focused on skills development and difficult to apply to clinical practice. It was not learner-centered, inactive and less interactive and inferior and boring.

"I think the traditional method is not good, ineffective because students only listen to teachers impart knowledge, not actively searching for knowledge to enrich their learning content".

"I rate the traditional method at an average level, usually after finishing the exam, I will not remember so much, only remember temporarily but not for long",

"… the traditional method is not student-centered, in the process of learning, students mainly listen to the lectures, sometimes, teachers combine with power point slides to teach",

"Actually, the interaction and interaction between students and lecturers is very rare, so many students may not understand some problems but are afraid to raise their opinions, hesitate to talk to the lectur-

Table 1. Students' perceptions of different teaching-learning strategies

Instructional strategy	Students' perceptions of different teaching-learning strategies	
	Advantage	Disadvantage
Traditional learning method	-Provide consistent and detailed knowledge; easy to understand and convenient to review -Providing appropriate study schedule -Leading good score in final examination	-Limitations on long-term memorization and expand knowledge -Less focus on skills development and difficult to apply to clinical practice -Non-learner-centered -Inactive and less interactive. -Inferior and boring. -Difficult to control learning effectiveness due to dependence on external factors: number of students, environment, capacity and culture of teachers
Problem based learning	-Proactive, positive and creative method -Deep learning approach -Increases interaction -Increases independence -Increases the ability to apply in clinical practice -Develop non-technical skills -Add more knowledge out of textbooks	-Takes a lot of time -Difficult to arrange time for group work -Uncertainty of information from internet -Knowledge acquistion limited of the whole lesson related to focusing mostly on dealing with their own group's problem solving assignment -Difficult to understand the lesson related to limitation on student's presentation skills and lack of concentration -Difficulties related to lack of computers and limitations in Power Point making skills
E-learning	-Convenience of approach -Stimulate learning process and improve learning efficiency -Improves independence and proactivity	-Limit the fairness in the examination -Depends on internet quality
U- learning	-Convenience of approach -Visual and easy to understand -Increases the ability to apply in clinical practice -Convenient and various styles in examination	-Depends on device quality

Table 2. Explore students' learning approaches related to various teaching strategies

Method	Surface approach	Deep approach	Strategic approach	Long-term learning outcomes
Traditional learning method	Textbook-based learning	Relating and organizing ideas and concepts	Self-testing/predict exam questions	Contributing good academic achievement
	Passive learner	Seeking meaning	Self-motivation	Efforts towards student's life and career
	Encourage self-learning	Seeking appropriate material/ resources	Seek help	
	Effective reading and listening skills	Relates theory to practice	Time and effort management	
	Syllabus-bound	Self-directed learning motivation		
		self-questioning strategy		
Problem-based learning method	Passive learners	Actively learners	Peer learning	
	Unthinking acceptance	Integrate theory and practice	Time management	
		Actively interact	Self-directed learning	
		Self-motivated/Motivated by interest	Group work	
		Systematic Memorization	Self-testing	
		Decision-making		
		Problem-solving skills		
		Critical thinking		
E-learning, U-learning method	Encourage self-learning	Seeking meaning	Time and effort management	
		Motivated by interest	Self-testing	
		Seeking appropriate material/ sources		
		Relating and organizing main ideas and concepts		

ers, hesitate to raise (issues) in front of the class"

The participants reflected on disadvantages of PBL learning methods, including perceptions about time, difficulties arranging time for group work, uncertainty about information found on the internet, knowledge acquisition for whole lessons versus mostly dealing with their own group's problem solving assignment, difficulties related to limitations on student's presentation skills and lack of concentration, difficulties related to lack of computers and limitations in Power Point skills. For online strategies, fairness in examination related to internet and device quality.

"…with PBL methods, it takes a lot of time to search for information, read and understand materials, then discuss in group to solve the problem, finally making PowerPoint presentation also takes too much time…",

"When doing assigned homework, some students just copy from books or internet into the presentation without understanding, then when other group members ask, they do not know and cannot answer",

"When we search for information on the internet, there are many sources so we don't know which one is reliable",

"For PBL, I only focus on my group, the knowledge given by other groups seems hard to understand because we don't have time to learn information of other group's part, so it's very difficult to absorb",

"I like to study on a tablet, but sometimes the server has problems, it always takes about 30 minutes to fix, to check if it's stable".

2. Exploration of student's learning approaches related to various teaching strategies

Based on guidelines in Newble and Entwistle's model (1986), the researchers reflected on the data and how different teaching strategies effect student's surface, deep and strategic learning approaches.

Within a traditional teaching-learning method, there are five elements within a surface learning approach: It is syllabus bound, textbook-based, involves passive learners, encouragement of individual learning, and promotion of effective reading and listening skills. Students perceived that traditional methods were still valuable, especially for basic nursing subjects. In this basic knowl-

Table 3. Suggestions for instructional strategies to promote student learning outcomes

Category		Traditional learning method	PBL method	E-learning method	U-learning method
Students	Students	Read textbook and take notes main idea/ confusing information before classes Actively ask/answer questions	Students need to be proactive, actively participate in learning activitives and responsibility in group work Sympathize with different point of views	Be active in learning, learn the lessons uploaded to the E-learning system before class Students have to active in arranging time for studying	Actively participate in group discussion
Lecturers	Lecturers	Develop pedagogical skills	Suggest important content if the student cannot comprehend Contribute ideas when students present a report		Download all lessons to learning devices Share other's group presentation to the U-learning system
	Teaching-learning contents	Create attractive content: brief, systematic slides, emphasizing the main idea, add more videos /images; update additional out-of-textbook knowledge, provide guidance how to apply knowledge to clinical practice	Scenario should be more realistic, suitable with clinical situation add more photos/ videos to make the lesson visual and actractive		Add more images, videos related to clinical case Ensure the quality of video/image
	Teaching-learning activities	Encourage students to participate in the lesson: Quiz, plus mark, group discussion Enhancing interaction between lecturers and students	Increase interaction between groups Provide reliable and official references Encourage students to actively participate in class	Enhancing interaction between lecturers and students: Group discussion	Utilize evaluation of course through the students feedback
	Develop skills training		Guide for students some skills before PBL courses: Searching references skills, making PowerPoint, presentation skills, giving/receiving feedback skills		
	Lectures/course evaluation	Lesson effective evaluation: Summarize main idea at the end of each part/ end of the lessons, giving evaluation questions	Summarize main ideas, update new information	Organize the exam at the university and ensure network quality	
Educational institution	Time/schedule management		Arrange a suitable schedule: PBL take a lot of time to prepare and discuss Should apply PBL from Year 1, for students to adapt to new method		
	Learning environment	Creating a favorable learning environment: Reducing the number of students in one class	Divide students into small groups Create an enjoyable, relaxed learning atmosphere		Ensure the devices quality

edge block, students needed a wide approach to knowledge acquisition, an ability to grasp the general knowledge and systematically connect the knowledge before focusing on the depth of the knowledge in specialized blocks. Therefore, given that they were getting knowledge from reliable resources such as textbooks, teachers' lectures were considered an effective resource. While promoting students effective reading and listening, it encouraged individuals to work on their own. However, traditional methods also bring negative effects to learners as familiarity with passive learning methods limits the intention to expand personal knowledge acquisition and thus become more autonomous learners.

"I think students should learn based on textbook, if they want to get high academic achievement, just repeat reading textbook as much as possible"

"In class, I focus on listening to lectures, underline main ideas in textbook, but I usually do not review until before examination, when I try to learn, I cannot remember anything, like reading them at the first time"

"I mostly self-study, I try to arrange study schedules to be appropriate for subjects. Before class, I read briefly lesson to grasp the main ideas,so when listening to lectures, it's easier to catch the lesson"

However, the following respondent makes a critical point:*"After finishing examinations, I mostly forget all knowledge I have been studying"*.

On the other hand, for students, no matter what method they are offered, they will try to find the best way to achieve the specified learning outcomes. Therefore, the deeper approach to learning is still used as an effective way to understand, link and use knowledge as needed. Qualitative analysis results showed six sub-categories related to deeper approaches:

Relating and organizing ideas and concepts, seeking meaning, Seeking appropriate material/resources, Relating theory to practice, Self-directed learning motivation and a Self-questioning strategy.

"I will note the main content of the lesson systematically on the note paper according to colors and stick it on the wall in each specific area, so I just need to look at each color area to remember lessons, it's a very effective and time-saving way to study",

"… when the teacher imparts knowledge, I try to take notes, if there is anything I don't understand, I will find more external materials to better understand or discuss with classmates",

"… when I read the lesson in textbook, I do not skim it, I read carefully to understand, focus on memorizing and learn by heart, then I search on You-tube to find and listen to related lectures. If I still do not understand, I will ask my friends or teachers",

"… combine clinical and theoretical study will help students understand more because there are still many clinical cases that are not exactly same (consistent with) with theory… find clinical cases which (are) described in textbook and because she has read the book already, she can easily find out the symptoms and compare those reality's signs to books' content",

"When reading a textbook, I usually read carefully and continuously ask myself the question "Why?", so it makes me remember lessons longer"

"… with the subject that I like, I will study more, also useful knowledge subjects, related to my health, my family health, I'm also more interested and motivated"

One response captured the value of an engaging teacher to encourage students to be engaged with the learning resource "If the teacher gives lectures attractively, I will listen attentively and write down the main ideas, but with boring lectures, I usually focus less on listening".

Within a traditional method, students applied strategies such as: Self-testing/predicting exam questions, Self-motivation, Seeking help and Time and effort management. According to participants, learning is a process that requires learners to have a clear goal and effectively manage time and effort, moving toward achievement. In this process, seeking appropriate help and maintaining motivation can also contribute to success. Also, proper orientation and practicing the exam questions can help students show results indicative of high academic performance around demonstration of knowledge acquisition. Retention of that knowledge might be short-term.

"To prepare for the in-coming examination, I usually do available exam questions paper and find out the form of these questions, which guides me on how to study to get high achievement"

"I usually study one month before the incoming examination, I make detailed plans using suitable time and effort, then I will read textbooks, find more information online, and do available exam papers"

"At the beginning of each semester, I will ask my seniors about their experience on how to study, which subjects are easy, which subjects are difficult, then arrange time and effort to study… ".

Regarding PBL methods, findings showed that the surface approach has 2 sub-categories: Passive learners and unthinking acceptance. According to passive learners, they only listen to lectures and do not pay attention to the presentation of other groups; they do not review lessons either.

"… I only focus on my group's presentation, often overlook the other groups' presentation… ";

"Participants described the unthinking acceptance as including copying the content of the lesson to present and copying information from the internet but have not read it all",

"… I copied the content in the book to make a report, but after

complete it, I did not understand…",

"…I copied the information from internet to make a report, but I didn't read it all…"

Findings revealed some of the sub-categories consistent with the deeper approach: Active learners, theory and practice integration, active interactions, self-motivated/motivated by interest, systematic memorization, decision-making, problem-solving skills, critical thinking.

For active learning, students want to improve knowledge and update information regularly; complete all assigned tasks and submit them on time; grasp knowledge to understand given problems; read the report of other groups posted on the available system; actively explore further; display self-learning; asking classmate/tutor about problems that they do not understand.

"…Each person needs to cultivate knowledge by themselves, in order to participate effectively in group discussion, do not be passive…",

"…In order to study well at PBL, I think that I should study for myself, read and learn more knowledge, not just passively listening to teachers…"

"For theory and practice integration, students think they have to apply theory to clinical practice; grasp clinical knowledge and practice more clinical skills",

"…I think we should combine clinical and theoretical study. Because there are many clinical cases that theories do not have, so students can learn more knowledge…",

"…In my opinion, students should go to practice more to know the real symptoms and how to handle them. It will be easier to apply and handle the situations in the lesson…",

Participants described active interactions consisting of giving questions/comments to others in the group or tutors: "*…In class, I ask teachers and other members when I do not understand the problems*"; or by interacting with other groups and question when needed"*…Listen to other group's presentations and make questions when we do not understand…".*

For Self-motivated/Motivated by interest, students showed interest in role play activities "*…Combining study and play roles helps to memorize lessons better…".* Creating a fun learning atmosphere and trying to answer other group's questions"*… will help everyone (learn) more actively…".*

Some students described Systematic Memorization as writing down the main ideas of lesson, then synthesizing these to learn more; reviewing carefully the report they have presented. Where confusing questions needed answers "*… in class, I also took notes of confusing problems that were answered…".*

For problem-solving skills, decision-making and critical thinking, participants described researcher enquiry processes -answering the question themselves or discussing these with team members to help make decisions and find the solutions for problems/situations/questions given by the tutor.

"…I will base (this) on the problem/situation, the questions that are asked by lecturers, then I will find out, follow this case content, answer the questions by myself, make a statement…".

Regarding E- learning and U-learning methods, students' reports on use of these approaches were quite similar to those for traditional methods. Students here however, were also engaging in self-learning, a surface strategy: Seeking meaning, being motivated by interest, seeking appropriate materials/sources, relating and organizing the main ideas and concepts thus moving towards deeper learning and being strategic with time and effort management and self-testing.

In addition, the participants responded to those teaching approaches that lead to long term learning outcomes including improving self-motivation, contributing to good academic achievement, and effort to improve student's later life and career.

"I want to get a very good degree at graduate level, and intend to get a job at an international hospital. Therefore, I set goals, make detail plan, and try my best to achieve…"(Table 2)

3. Describe suggestions for instructional strategies to promote student learning outcomes

Students' reporting revealed three major categories: Feedback about their experiences, the lecturers and the educational institution in relation to optimal improvements in teaching and learning strategies when applying new active learning methods. The lecturer category involved feedback on teaching-learning content; teaching-learning activities; developing skills training; and lecturer/course evaluation as well. The educational institution category was focused on time/schedule management and learning environment.

In the traditional method, students are central when improving/optimizing their own learning strategies. Specifically, in the students' own views, to improve learning strategies, students have to read textbooks and take notes about the main ideas/ confusing information before classes and then ask about or answer questions.

Findings illustrated the idea that lecturers were they key to stimulating student learning; they had to develop their pedagogical skills and create attractive content: Use brief systematic slide presentations, emphasize the main ideas, add more videos/images; update additional out-of-textbook knowledge, provide guidance on how to apply knowledge to clinical practice. Furthermore, encouraging students to participate in the lesson, but also respond to quizzes, added incentives to achieve more marks, engage with group discussions; enhancing interactions between

lecturers and students. Summarizing the main idea at the end of each part/end of the lessons and giving evaluation questions were also suggested. Last but not least, students noted the importance of creating a favorable learning environment, for example by reducing the number of students in one class also added to the optimizing learning and teaching strategies.

"*Lecturers should encourage students to participate in the class by plus mark; or after each lesson, the lecturer should give the short evaluation questions to build up student's knowledge*",

"*In my opinion, lecturers should enhance the interaction between lecturers and students, it means that they should not stand / sit in one place; should go up and down; give questions; commend when students answer correctly; the knowledge should be systematized at the end of lessons*",

"*I think the class should be reduced the number of students, provide spacious and airy classrooms, because when sitting in the crowd class causing heat, difficulty concentrating and easily chatting*".

Data showed that in the PBL method, students perceived the need to be proactive, actively participate in learning activities and take responsibility for participating in group work and also remain sympathetic to different points of view and "*… complete the assigned work*".

There may be a range of reasons for findings that revealed impressions of how students perceive elements within the lecturer category: It was suggested lecturers should:

First, suggest important content if the student cannot comprehend; contribute ideas when students present a report. Second, work with scenarios that should be more realistic and suitable for clinical situations; add more photos/videos to make the lesson visual and attractive.

Third, increase interaction between groups, provide reliable and official references, encourage students to participate in class and gain extra marks;

Fourth, guide students through the development of some skills before undertaking PBL courses: Reference search skills, making PowerPoints and oral presentations, giving /receiving feedback, summarizing main ideas, updating new information.

The educational institution should respond to the differences in processes involved with PBL activities: "*Divide students into small groups; create an enjoyable, relaxed learning atmosphere; no pressure*". To achieve this, "*I think teachers and the university should arrange suitable schedules: PBL courses need a lot of time to prepare assignments and group discussions. And we should apply PBL method from Year 1, for students to adapt to the new method*".

When glancing at the feedback on E-learning methods, one can readily see that students have to be active in learning, engage with the lessons uploaded to the E-learning system before class and also be active in arranging time for studying.

On the other hand, it was suggested lecturers should enhance their interactions between students through group discussion and ensure network qualities were reported by students: "*Lecturers can give discussion questions to increase interaction between lecturers and students; attract more students*".

Exam organization was an issue.

"*… in order to ensure fairness in the test, it is advisable to conduct the test at the school, because when taking the test at home, the network of each students is also different, fast and slow, so some students can not take the test smoothly*";

"*I think the test should be conducted at school; prepare a private room, ensuring network quality for students to do the test at the same time; no exchange between students*".

Student perspectives about U-learning centered on the need to actively participate in group discussion. Lecturers should download all lessons to quality learning devices and share all group presentations using the U-learning system. The addition of quality images and videos related to clinical cases and marks allocated for active students would improve learning strategies (Table 3).

Discussion

Study findings indicated advantages and limitations within students' perceptions toward different learning methods. These are discussed with reference to other studies.

Making comparisons among teaching strategies, participants saw PBL as an effective approach for achieving learning outcomes; PBL encouraged proactivity, convenience, and creativity. Visual content enhanced active learning for several core skills. Clyne & Billiar (2016) had similar findings: PBL has been effective in motivating student learning, increasing knowledge retention, and developing problem solving, communication, and teamwork skills. The findings of Rodger & Stewart-Lord (2020) main themes were "openness to diverse viewpoints", "developing non-technical skills" and "encouraging deep learning". In Al-Kloub et al. (2014) study, participants reported effectiveness through PBL in developing cognitive abilities, independent learning, motivation to learn, and group learning.

There were perceptions of disadvantage in use of PBL methods. Limitations in learning processes included: Students take a lot of time to complete group assignments; uncertainty about information on the Internet; limits on amount of knowledge acquired when the focus is on group processes. Al-Kloub et al. (2014) had similar findings, PBL is time-consuming, has unclear objectives, is a stressful process, and results in an increased workload. E-learning has some limitations: Fairness in examinations;

some students like the 30% described by Eldeeb (2014), have difficulties related to internet and Wi-fi quality.

Using Newble and Entwistle's model guidelines (1986), these study findings show that different teaching strategies impact differently on student's learning regarding surface, deep and strategic approaches. Teaching strategies impact different learning styles in the short and long term. Learning outcomes including improving self-motivation, good academic achievement affect student's life-long learning and careers. In the study of Bhalli et al. (2015), findings showed that instructional strategies accommodating learning styles enhanced academic performance. Previous studies point to significant relationships between the two (McKenna et al. 2018; Shirazi & Heidari, 2019), teachers' professional satisfaction and support for ongoing professional nurse training (Vizeshfar, F., & Torabizadeh, C. 2018). Ford et al. (2016) findings demonstrated that individual learning styles and teaching strategy had impacted quality improvement processes for teachers and practice-based learning. Dolmans et al. (2016), showed PBL enhanced active learning and students' intrinsic motivation for improve deep learning but acknowledged high perceived workloads through assessment aiming for enhancing surface learning. Sajadi et al. (2017) recognized use of learning contracts in clinical settings was indicative of greater self-directed learning among nursing students.

Given the discussion above, it is clear that selecting appropriate teaching strategies was seen as important for effective learning outcomes in the short and long term. In this study, participants' suggestions for instructional strategies for promoting student learning outcomes regarding the context of student, instructors and educational institution. Although different teaching strategies were provided, participants commented that improvements to learning were needed aiming for more up-to-date reality-based and attractive learning events, not those based on information available in books. Participants' experiences demonstrated that interest in learning was one factor that increased academic engagement, increased appeal towards subjects or educational content. Ghasemi et al. (2018) study, showed that interest in, and intellectual and mental concentration on educational subjects, increased learning efforts, and ultimately contributed to greater and deeper learning. According to Joshi et al. (2017), participants' suggestions to achieve high learning performance referred to consideration of learning styles and strategies like daily revision of topics, being regular and attentive during ward postings.

Activities offered in a lively atmosphere with interactions between students and teachers contribute to improving learning efficiency. Gablinske (2014) reported that teacher interaction behaviors refer to specific actions that allow for positive communication between the teacher and students; various components of interactions have a direct impact on the instruction and learning that occurs at every moment of learning engagement. Dinkevich & Ozuah (2003) indicated that

those participating in a problem-solving skills workshop showed significantly higher self-directed learning levels than their counterparts. Skedsmo & Huber (2018) reported that to evaluate teachers' influence on their students' improvement learning achievement, one needs to consider the approach or model adopted for the assignments.

The participants in this study suggested that subjects should be spread throughout the semester, not focusing on multiple subjects at a time to avoid a decrease in academic quality. Joshi et al. (2017) study found that in unstructured timetable, lack of planning was identified in student's low performance. Thus if participants were given reasonable learning schedules, with suitable clinical practice time, effective gains in learning were achieved. In relation to student's knowledge acquisition, a study by Kashif & Basharat, (2014) showed that the class size and its relationship to student engagement in classrooms could not be neglected; students lacked a spirit of 'engagement' in large classes.

CONCLUSION

The findings of this study provide insight into students' perspectives on advantages and disadvantages of offering different educational strategies, and the influence of these on their approach to learning. Suggestions for instructional strategies and enhancing learning outcomes need to be seen in the context of student, instructor and systems. Further studies focusing on applying the findings to ways to improve academic engagement are recommended.

Given that nearly a decade ago, MOET suggested that the teaching methods in higher education in Vietnam were not effective because the focus was not on encouraging students to be more active in learning events, we also need to ask "To what extent have we achieved the goals set for students involved in higher education?

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Integration: Achieving Coherence Between Education and Practice in the Professions

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Integrated health services, focused on prevention, anticipate needs and support people to manage conditions, especially in compromised environments. Learning about contemporary, integrated health care is best achieved through integrated approaches to education. Contexts of care are crucial moderators of ways professionals respond to demands. The world of work is complex: In health services measures of safe and therapeutic practice differ across settings; cultures and contexts vary for different client groups; there is a range of capacities and levels of competence within professional and inter-professional groups; and, there are different approaches to managing well in crises. Implicit in successful, rapid responses to crises, are the capable workforces with particular abilities to deal with new situations. The authors suggest that Problem-based Learning (PBL) principles underpinning ideas on integration within and across education and practice, allow for validation of relevant concepts. Goals for Person-Centred Care (PCC) espoused by the World Health Organization apply in a range of situations, including the COVID19 scenario and will be reflected in students' learning outcomes. Given COVID19 challenges, health professions (within healthcare and education systems) recognized the need to adapt and innovate to provide effective patient care and ensure ongoing learning for existing and emerging professionals. Technologies assisted change processes, with limited resources. However, the extent of compromise on levels of integration in practice and education is unknown. Answers to questions posed here will assist with responses to global disruptive phenomena; lessons learned provide direction for management of chronic diseases, healthier living and engagement with the professional education that facilitates rapid responses to novel situations.

Keywords: Integration; Education for the professions; Frameworks for education and practice

Review Article

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INTRODUCTION

In this paper we examine the current dynamic environment that has arisen because of the pandemic. Responses to COVID 19 demand health professionals who are creative problem-solvers and work with others to deliver quality care appropriate to the context and the individuals. We argue that there is a priority for professionals who can respond to novel situations within an integrated framework. Educational methodologies like Problem-based Learning (PBL) lead to learning outcomes (abilities) that can be used in actual practice. In responding to this priority and the complexities arising from the COVID19 pandemic, the authors reinforce the idea that educating health professionals requires the use of a conceptual framework of professional education that aligns with that of integrated care. PBL curricula provide scaffolding for integration of ideas and facilitate modification of learning activities when necessary.

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BACKGROUND

The contexts of care and learning are crucial moderators of the way emerging and practicing professionals respond to demands on them. The world of work and ongoing professional development is complex: Measures of safe and therapeutic practice differ across settings; cultures and contexts vary for different client and student groups; there is a range of capacities and levels of competence within professional and inter-professional groups; and, there are different approaches to managing well within crises in a variety of health service and educational structures and processes.

For example, given the impact of the emergence of the COVID19 challenge (News, The Lancet, 2020), health professions (within the healthcare and education systems) were forced to adapt and innovate to continue to provide effective patient care and ensure ongoing learning for existing and emerging health professionals. E-technologies assisted the change processes, even where there were limited resources. However, the Deloitte Center for Higher Education Excellence (2020) highlighted the extent to which the pandemic has upended business as usual for colleges and universities. Not only have campuses shifted to remote learning almost overnight, but institutions are also suddenly grappling with grave financial challenges as the domestic and global economies may now face what looks to be a severe recession.

Aristovnik et al. (2010) completed a comprehensive and large-scale study on student perceptions of the impacts of the COVID19 crisis on their lives. A study sample of 30,383 students from 62 countries, reported on perceptions on various aspects of the worldwide lockdown and transition to online learning. Support provided by teaching staff and their universities' public relations offices was a source of satisfaction for students. But limitations arising from their deficient computer skills and the perception of a higher workload 'prevented them from perceiving their improved performance in the new teaching environment'. Students have had to engage differently with educational programs.

The demand for a rapid shift in focus is now a global phenomenon; changes in health services will provide direction for the future if the professions are to adequately assist people to stay alive, manage their chronic diseases and live healthier lives at home.

Across the world, the response to the pandemic was well-publicized by the World Health Organization (WHO, 2020). In Australia, we have seen that an integrated health service and care system with a focus on prevention, anticipated needs and supported people to manage their conditions especially in compromised environments. Learning about contemporary, more integrated health care can best be achieved through an integrated approach to education. However, quality educational processes can be readily compromised in crisis situations.

WHO (2016) argued for an orientation towards more integrated care to meet aspirations for more Person-centered Care (PCC): In Australia, a rapid response to the COVID19 crisis was evident in the way health services and higher education were able to 'pivot' to work with structures and processes to respond rapidly to situations in a person-centered way. The WHO support for a more strategic 'all-encompassing' approach seems relevant in crisis management; the coordinators within service provision reflect their ambition to:

- Put people and their needs first
- Re-orient the model of care
- Re-organize the delivery of services
- Engage patients, their families and carers
- Rearrange accountability mechanisms
- Align incentives
- Develop human resources for health
- Uptake innovations
- Partner with other sectors and civil society
- Manage change strategically.

(WHO Regional Office for Europe. Lessons for transforming health services delivery: Compendium of initiatives in the WHO European Region).

CONTEXT AS A DETERMINANT OF STRATEGY

Professionals working in any field require access to evidence-based knowledge and know-how. In health services, the latest evidence informs care delivery processes in pursuit of optimal patient outcomes and greater assurance of quality and safety for both consumers and peers. We saw that evidence from experts on COVID19 informed decisions about how to achieve integration of services and processes in, and from a range of workplaces.

Blueprints for education, training and professional development should lead to relevant learning outcomes on which the clinician can build when novel situations present in the rapidly changing contexts. Professionals will rely on particular core abilities if they are to respond well to pressing issues, for example:

- Crises such as the emergence of COVID19
- Demographic changes and the impact of those trends on health, education and social policy and practice
- Less than optimal care and concern for people, instead of care as needed and in the right places
- Fiscal restraint and the drive for greater efficiencies.

Identifying and developing the required core abilities of practitioners within health services is the challenge for education for and within the health professions. Hendry (2017) identified the core elements of integrated practice as those that center on

- context/care/service provision,
- person orientation,
- involvement in care processes,
- self-determination/choice and
- growth potential.

Education for integrated practice and models of integrated care are both informed by core concepts and values, such as those described by Hendry, and principles relevant to all aspects of health professional practice. Consumers are at the center of designs for service provision; students as consumers of education programs are central to learning in preparation for practice roles.

IMPLEMENTATION OF INTEGRATED CARE

To achieve outcomes espoused by Hendry (2017), the design and delivery of care needs to demonstrate

- Coordination and continuity of care
- Trusted relationships
- Accessible information and advice
- Consistent communication with, and between, staff

Hendry suggested there was a particular need for Registered Nurses (RNs) with specialist qualifications who have the abilities to work with GPs and healthcare support workers to

- promote self-management and independence
- use skilled assessment working with a person and their family to develop their care plan
- focus on prevention and anticipatory care management and coordination of care
- ensure collaboration with other disciplines
- use knowledge of local resources/networks.

Vulnerable populations are always the focus of policymakers. Older Australians, those impacted by mental distress and those with symptoms of a range of chronic diseases demanded special attention during the pandemic. Many had existing co-morbidities. Hendry (2017) from Scotland, provided evidence of a paradigm shift in approaches to the management of people with one or more symptoms of chronic diseases across the world. What matters to consumers Hendry said is that: "My care is planned with people who work together to understand me and my carer(s), put me in control, coordinate and delivery services to achieve my best outcomes" (National Voices, 2012) Health professionals, especially nurses who are accustomed to learning about and dealing with an older clientele, have been prominent in the societal response to COVID19; nurses were central to both practice redesign efforts in acute care and preventive strategies to ensure public safety. Hendry outlined what she described as 'anticipatory care interventions' that are targeted and tailored to the individual

- Self-management and advice and support including for dementia
- Polypharmacy reviews of safety, efficacy and adherence
- 'Thinking ahead', 'anticipatory' electronic care plans,
- Physical activity, falls prevention and management
- Identification and support for carers
- Coordinated case management for complex support
- Re-enablement and 'step-up/step-down' Intermediate Care
- Comprehensive geriatric assessment for frail older people
- Tele-health and tele-care
- Equipment for adaptations.

However, relationships and interactions need to be facilitative, indicative of partnerships, considerate of legal and human rights and the maintenance of dignity and respect for the recipient of care. Given that health and health-breakdown information is now more readily available online, health literacy is also encouraged, especially among the diverse cultural groups within the broader populations.

While there are specialized fields like cancer and mental health care which focus on working with consumers to meet their recovery and re-enablement goals, consideration of the person's physical, psychological, social and spiritual needs is also paramount. Today in most fields of health service, care processes need to consider the context of the person's lived experience, partnerships with their family, significant others and the broader community. Providing support for consumers and their families during life crises and transition periods is critical. Professionals in Australia have to liaise discretely and effectively with a range of health care providers, provide information and education on health maintenance and restoration, and coordinate care across contexts that span metropolitan, regional, rural and remote areas. The health workforce needs to be flexible and responsive and able to work with people across the life span, and in a variety of workplace settings, especially during crises.

As noted above, sustaining a more integrated approach to both practice and education demands a strategy informed by principles. These also apply to modifications made to blueprints for preparation for practice in all professional fields in uncertain circumstances such as that thrown up by COVID19. When the nature of work and workplaces change, different approaches to practice and education are required. In our local health services,

one recent focus for change as a response to COVID19, related to managing people with chronic disease and multi-morbidities outside of the acute care environment. Primary health care came to the fore. Evidence had already suggested that those health systems involving primary health care were more efficient, have lower rates of hospitalization, fewer health inequalities and better health outcomes, including lower mortality (Australian Government, Department of Health, 2020). Health and information technologies have now opened up further access to all kinds of services, extended options on who can deliver services and where the service is delivered.

Before the emergence of COVID19, drivers for change in models of care and system redesign had already informed Australian Health Plans such as the NSW Health (2016) pilot studies for the implementation of more integrated care. Of particular interest was a focus on bi-directional physical and behavioral interventions for primary care clinicians. But also recognized as critical, was the need for assessment and management of mental health and substance abuse. However, additional considerations in responses to COVID19 included the importance of the creation of safe and healthy work environments, excellence in personalized patient care, meaningful education for patients and their carers and the wider population, leadership in innovation, health and information literacy, safe medication management, research and community services.

EDUCATION FOR CHANGE

As already noted, implicit in the successful contribution of the professionals' role in change is the development of the type of education programs that develop particular core abilities (applied learning outcomes) derived from an analysis of the professional practice, workplace and societal contexts. Working in inter-professional teams to deliver person-centered care has long been a goal of health services. Organizational structures have often facilitated the achievement of these outcomes. In a previous consultancy undertaken by one of the authors, staff members from the community, aged care and disability and educational services came together. These staff members were taken through a process to generate what they considered the core capabilities of all staff should be, provide parameters to guide inter-professional practice, drive organizational change, and maintain the collaborative, person-centered culture of the unit. The following core competencies (abilities) were identified through an analysis of data collected through workshops, focus groups, interviews, and practice narratives:

1. Provides person-focused care
2. Contributes to multi-professional client management;
3. Uses an evidence-based approach to practice
4. Engages in creative problem solving
5. Engages in ongoing professional development
6. Accepts shared responsibility for the Organizational Unit

The notion of shared responsibility was thought by all levels of staff participants to be the essence of collaborative practice and change and creative problem-solving at both the individual client and the broader systems levels; this was considered essential to the provision of optimal integrated care (Conway et al., 2011). While integrated care focuses on the individual consumer as central to the delivery of services, we acknowledge that the achievement of this outcome requires a whole of services approach and involves patients, clients, carers, family, volunteers, communities, institutions, and governing bodies.

Fostering the required capabilities in existing staff in health services through appropriate and relevant education and training can only be achieved when education and training take place in the context of workforce capability and organizational development. The approaches acknowledge systems within organizations or services that inhibit the application of the education and training outcomes and contribute to the development of a culture consistent with the elements of a 'learning organization'.

Educational methodologies and curricula designs such as Problem Based Learning (PBL) and Context-Based Learning (CBL) have long espoused the centrality of professional practice in education for the professions. The rationale for, and underpinning philosophy of PBL, argues that the world has been experiencing such rapid change that the goal of professional education is to equip graduates with the required abilities to respond to change and novel situations: Critical thinking, problem-solving and situation-analysis, self-directed learning and ongoing development, and an ability to work in intra- and inter-professional teams. PBL approaches achieve these outcomes by using a carefully selected range of situations from practice as the context for learning. Integration of knowledge from contributing disciplines is more meaningful for students. The use of appropriate performance-based assessment in PBL also results in the integration of knowledge, skills and values when responding to novel situations.

All university, vocational education and health service program development and implementation are subject to cyclical review processes guided by the higher and further education sectors. Participation of academics and clinicians from the practice arena provides a chance for an appreciation of maintenance of a level of integration in design and implementation processes. However, in the COVID19 situation, educational institutions were forced to move rapidly to more blended approaches reliant on e-learning.

Some had systems in place; others needed to revolutionize more traditional ways. Hence decisions on organizational, practice and education renewal should also have included resources that support appropriate education and training.

The more blended and integrated approaches to education might have had some advantages in the crisis. A perusal of websites and program offerings suggests some providers have well developed conceptual frameworks for integration within program offerings; some espouse integrated philosophies and methodologies, and some directly relate to integrated services.

DESIGNING CURRICULA FOR INTEGRATED CARE

When articulating a pathway to integration, it is essential criteria and supporting values and principles form part of any overarching framework. When using a conceptual framework for a curriculum design that equips health professionals with abilities to participate in, provide and promote Integrated Care, it is necessary to align educational and practice conceptual frameworks. Over the years the International Foundation for Integrated Care (IFIC) has developed and used a series of building blocks as a conceptual framework that supports the successful delivery of integrated care services: There website outlines these as

- Shared Values and Vision
- Population health and local context
- People as partners in care
- Resilient communities and new alliances
- Workforce capacity and capability
- System-wide governance and leadership
- Digital Solutions
- Aligned payment systems
- Transparency of Progress, results and impacts.

An "examination of practice through curriculum development processes results in testing the congruence of existing conceptual frameworks of any discipline in the reality of contemporary practice". Scrutiny can raise questions about the relevance of espoused values and theories of professional practice to contemporary and future practice (Conway & Little 2000). McMillan & Little (2016) illustrated the congruence between models for professional activities and education with some examples of elements of both. Conway & Little (2000) also argued that when PBL curricula reflects practice, staff members will articulate professional and/or discipline values and their educational practice values. Through the application of these to the 'real-life' situations captured in learning packages, the staff themselves repeatedly test their espoused theories of education and their profession/discipline. They are required to demonstrate the process skills that underpin the PBL curriculum. This testing of assumptions, defining concepts of the profession/discipline and education and applying them in the context of their own 'real-life' teaching situations are the ongoing challenges for academics and clinicians in implementing PBL (Conway and Little, 2000).

CORE CONTENT, STRUCTURE AND DELIVERY MECHANISMS

The knowledge, skills and attitudes for greater integration in practice and education exist in health service plans and education provider policy frameworks that guide curriculum development, implementation and renewal. Integration of core concepts is necessary: Recovery/re-enablement, consumer-practitioner partnerships, therapeutic relationships, consumer-centered co-constructed care and ethical and other issues relevant to professional practices. When considering the curriculum structure and delivery mechanisms that best accommodate learning events which embrace concepts and content relevant to contemporary practice, modularization is a useful way to achieve the renewal of content when necessary. A significant component of any curriculum design is the assessment that provides evidence of learning outcomes (graduate abilities). Responses to COVID19 had the potential to undermine adherence to best practice principles for assessment tasks (in terms of graduate abilities) needed for any learning event: Equity; transparency of performance criteria; a balance of reliable and valid activities that support student learning. Workplace learning was impacted as workplaces changed, given the potential spread of infection. But as curriculum plans changed, in response to the pandemic, three principles still needed to inform the choice of assessment activities based on outcomes related to performance in the workplace.

CONTEXTUAL RELEVANCE TO THE WORKPLACE

Achieving the abilities defined in the learning outcomes requires the application of knowledge, skills and professional behaviors to workplace situations and demonstration of an ability to respond appropriately in these situations. The workplace situations used as stimulus material for learning should reflect the demands of the real world of practice and the potential for transformation. A range of assessment tasks employing application to a workplace context can collect evidence of this ability.

INTEGRATED, PERFORMANCE-BASED ASSESSMENT

Assessment of workplace competence requires a broad range of performance-based evidence to support the achievement of the learning outcomes (graduate abilities). The focus of the assessment tasks should center on the integration of knowledge, skills and professional behaviors to develop appropriate responses to workplace situations.

EVIDENCE-BASED ASSESSMENT

The process of assessing learning outcomes expressed as graduate abilities requires the accumulation of evidence regarding individual performance over time and from a range of valid and reliable assessment modes. The assessment of performance should involve feedback from academics, clinicians, peers, self, consumers and other relevant stakeholders. Mapping processes will ensure appropriate coverage and weighting of assessments and links to each of the learning outcomes. Evidence gathered of achievement of learning outcomes (graduate abilities) should include practical demonstrations of achievement, including work environment demonstrations, simulation exercise, scenario or role-play.

Indirect evidence will be available from work environment supervisor reports, workplace documentation, and written responses to problems/situations, scenarios and consumer-story vignettes.

Responses limited the usual choices from the range of examples of relevant assessment tasks to the pandemic: Written examination, assignment, consumer-based, solution-based, Objective Structured Clinical Examinations (OSCE), consumer-story vignettes study, or viva. Some options were no longer possible for safety reasons.

Despite the need for rapid responses to the crisis, the evidence of performance should still be obtained during modules, units, workshops, clinical practice to inform a judgment of competence and confidence. The evidence should readily align, through mapping, with the identified learning outcomes (graduate abilities).

DISCUSSION

Through the efforts of the IFIC strong theoretical foundations are emerging, the evidence-base has been tested and are underpinned by values which ensure that care processes and treatment are therapeutic, that is helpful and salient, especially during the COVID19 crisis (https://integratedcarefoundation.org/realising-the-true-value-of-integrated-care-beyond-covid-19). While some core values are not unique to particular disciplines, they underpin the learning outcomes and the principles underpinning learning and teaching across the health professions.

During the COVID crisis, nurses had a distinct contribution in that there is a purposeful and time-intensive contact with the consumer, and commonly also with their families and significant others. This is important for people experiencing mental illness and distress during the pandemic. In our experience with education and policy forums, mental health care provides an excellent example of the importance of integration in health care and education processes. Nurses engage with the everyday lived experience of consumers and 'understand how this experience is complicit in their health profile and consequences'. The distinct way of relating and interrelating with consumers and their families distinguishes mental health professionals in their practice; these ideas were part of a framework for studies in that field (McMillan & Little, 2016). However, mental health challenges and distress feature alongside a range of other symptoms of a disease; the same concepts can contribute to the development of a values-based conceptual framework for practices aspiring to greater integration in care processes and outcomes that are:

- Person-centered, in tune with the person's 'life needs' as well as their health needs; aspirations for recovery and re-enablement, are always central to care plans
- Reliant on the health professional's world view, i.e. individual commitment to consumer-generated care that is consistent with the best available evidence
- Centered on mutually beneficial collaboration with consumers and others through partnerships
- Consistent with opportunities to reflect on plans that meet peoples' needs.

In summary, the distinctive contribution of integrated care evident in health services is characterized by an approach that is collaborative and co-constructed with the consumer and their family. As a consequence, there is a commitment to re-enablement and recovery for individuals receiving health care. The philosophy and understandings about the nature of the practice should be readily evident in the conceptual models of educational preparation for beginning and more experienced professionals. It should reflect current research into optimal practices and outcomes. McMillan and Little (2016), when developing a Framework for post-graduate studies in mental health nursing in Australia, argued that benchmarks guide best practice in developing, implementing and maintaining curriculum integrity. Values and principles were consistent with aspirations for integrated practice and education. Practices are driven by policies that drive integra-

tion in and across practice and curriculum documents (subject/unit outlines, assessments, clinical placement records and schedules) student evaluations, formal agreements with clinical agencies and involvement of health service consumers and family/carer representatives.

However, the IFIC membership, in their advertisements for forthcoming forums, suggest that many questions remain if we are to achieve an appropriate level of integration in health services and care. These involve

The Future of Health and Care – What are the challenges, opportunities and unknowns that need to be considered by health and care systems to future proof health and care services for patients? Thinking about the pandemic responses, technology advancements, changes in demographics, attitudes/behavioral changes, international turmoil, climate change – What is the leadership required? What are the impacts on the workforce? How can we achieve universal access to health services?

The Future of Health Professional Education – What are the challenges, opportunities and unknowns that need to be considered by education systems to future proof student learning for evidence-based practice – thinking about the pandemic response, technology advancements, changes in demographics, attitudes/behavioral changes, international turmoil

What leadership is required? What are the impacts on the workforce? How can we achieve universal access to ongoing learning?

CONCLUSION

In the current environment, there is a priority for professionals who can respond to the demands of practice in complex and dynamic contexts of care. Educational and workplace learning outcomes (abilities including critical thinking) therefore need to be expressed as they are applied and used in actual practice. The education experience must go beyond providing acquisition of knowledge and skills to the 'application of that knowledge and skills in the context of practice'. The competing tensions in beliefs and values seen in responses to the disruptions caused by the COVID19 pandemic highlighted the complexities of the real world. This paper reinforces the authors' belief that PBL philosophy and methodologies are appropriate for educating health professionals in the concept of integrated care because PBL requires the use of a conceptual framework of professional education that aligns with that of integrated care.

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Problem-, Project- and Design-Based Learning: Their Relationship to Teaching Science, Technology and Engineering in Schooll

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Purpose: The present study aims at shedding light on the meaning of three teaching and learning methods - problem-based learning, project-based learning and design-based learning, aimed at fostering students' lifelong learning skills such as problem solving, collaborative learning and self-direct learning.
Methods: This work is derived from the literature of constructivist pedagogy, and student-centered teaching and learning methods with focus on science, technology and engineering.
Results: Problem-based learning has to do mainly with creating theoretical knowledge, for example in science or mathematics. In project-based learning, there is a longstanding tradition in schools for "doing projects," incorporating "hands-on" activities, developing interdisciplinary themes, implementing laboratory investigations and the creation of a useful artifact or system. Design-based learning corresponds to project-based learning, except that DBL requires learners to work according to acceptable engineering design processes. In the hearth of engineering design is generating alternative solutions and choosing systematically the optimal one, because engineering is merely a process of optimization and tradeoff.
Conclusions: In the present article, we have highlighted the differences between three problem-based learning, project-based learning and design-based learning, with hope that becoming familiar with these teaching methods will encourage educators and engineers to integrate them into teaching science, technology and engineering in schools.

Keywords: Constructivist pedagogy; Problem-based learning; Project-based learning and design-based learning

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INTRODUCTION

The rapid scientific, technological and social changes and the digital revolution in particular, have been altering almost every aspect of life, for example, the ways people work, shop, communicate, travel and spend their leisure time. To prepare students to integrate into the modern world and work place, schools are required to impart to students not only knowledge in science, technology, engineering and mathematics (STEM), and computing, but also lifelong learning skills. This includes the ability to solve problems, work both independently and on a team, communicate effectively in different formats, and self-direct one's learning (OECD, 2018). To reach these goals, education must move from the conservative lecture-based teaching method to constructivist learner-centered instructional methods such as problem-based learning, project-based learning and design-based learning, which are derived from seminal philosophers and educators such as Jean Piaget (1896-1980), John Dewey (1859-1952) and Seymour Papert (1928-2016). However, the three terms mentioned above are somewhat am-

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biguous, and the difference between them is unclear. The purpose of this article is to shed light on the meaning of the terms problem-, project- and design-based learning within the context of teaching science, technology and engineering in school.

PROBLEM-BASED LEARNING (PBL)

Problem-based learning is a student-centered pedagogy in which students learn about a subject through the experience of solving an open-ended problem found in the literature. The PBL process does not focus on problem solving with a defined solution, but it allows for the development of other desirable skills and attributes such as knowledge acquisition, enhanced group collaboration and communication.

Problem-based learning is often described as including the following steps:

1. Explore the issue
2. State what is known
3. Define the issues
4. Research the knowledge
5. Investigate solutions
6. Present and support the chosen solution
7. Review your performance.

Problem-based learning was originally developed within the context of medicine studies, but the use of PBL has expanded to include education in areas such as science math, computer sciences law, economics, business and social studies (Barrow, 1996; Hmelo-Silver, 2004; Kim, 2019; Savery & Duffy, 1995). From the perspective of STEM education, problem-based learning has to do mainly with creating knowledge, for example in science or mathematics, or computer sciences, in which the problem and the solution could be on the theoretical level only.

PROJECT-BASED LEARNING (PjBL)

Project-based learning (sometimes also called PBL) is a model that organizes learning around complex tasks based on challenging questions or problems that involve students in design, problem-solving, decision-making, or investigative activities (Thomas, 2000). In project-based learning, there is a longstanding tradition in schools for "doing projects," incorporating "hands-on" activities, developing interdisciplinary themes, implementing laboratory investigations and the creation of a useful artifact or system (Barak & Zadok, 2009; Blumenfeld et al., 1991; Vargas, Ortiz, Pueyo, & Rodríguez, 2019). Project-based learning is often described as comprising five main stages: identifying a problem or need; investigating; planning a technological device; construction and troubleshooting; and evaluating, as illustrated in Figure 1.

Students' projects could include, for example, a robotics or automatic irrigation system. It is important to note that project-based learning is a cyclical and not a linear process. Moreover, this is an iterative process in which a developer can jump back or forth from one stage to another.

DESIGN-BASED LEARNING (DBL)

The term design is associated with engineering. Design-based learning is similar to project-based learning, except that DBL requires learners to work according to acceptable engineering design processes.

Burghardt and Hacker (2004) suggested the term 'informed design cycle' including the following eight stages:

1. Clarifying design specifications and constraints
Describing the problem clearly and fully, noting constraints and specifications.
2. Researching and investigating the problem
Searching for and discussing solutions to solve this or similar problems. Completing a series of guided-knowledge and skill-builder activities that will help students identify the variables that affect the performance of the design, and inform the students' knowledge and skill base.
3. Generating alternative designs
Not stopping when we have one solution. Approaching the challenge in new ways and describing alternatives.
4. Choosing and justifying the optimal design
Rating and ranking the alternatives against the design specifications and constraints. Justifying a choice that will guide the preliminary design.

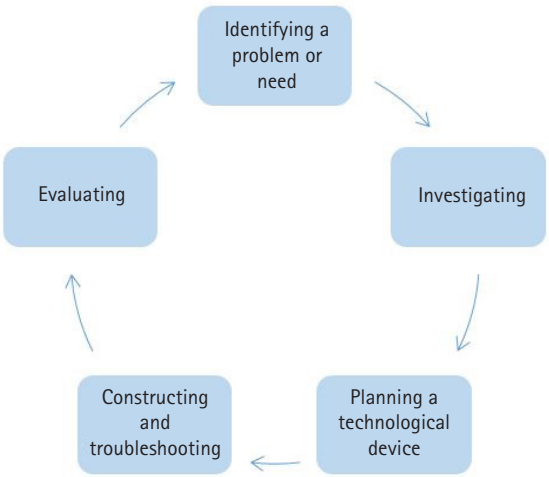

Figure 1. Project-based learning process.

5. Developing a prototype
Making a model of the solution. Identifying and explaining modifications to refine the design.
6. Testing and evaluating the design solution
Developing and carrying out a test to assess the performance of the design solution.
7. Redesigning the solution with modifications
Examining the design compared to other solutions to see where improvements can be made. Identifying the variables that affect performance and determining the concepts that underlie these variables. Explaining how to enhance the performance of the design using these concepts and variables.
8. Communicating the achievements.
Completing a design portfolio or design report that documents the previously mentioned steps. Making a group presentation to the class justifying the design solution.

In this case, too, we must note that the design work is an iterative cycle in which a designer can move back or forth from one stage to another; it is not a linear process.

Stages 3 and 4, Generate alternative designs and Choose and justify the optimal design, are central to the engineering design because engineering is merely a process of optimization and tradeoff. Designers often cannot develop a product or system that fully meets all requirements, for example, in terms of performance, ease of use, reliability, safety, or cost. They develop several solutions and systematically check for the optimal one, for example, by preparing a performance scale for choosing the optimal solution. These steps, which are at the heart of design-based learning, are less central to the general model of project-based learning mentioned above. In fact, DBL differs from PjBL mainly in this aspect.

Students' activities in problem-, project- and design-based learning

Problem-, project- and design-based learning are forms of constructivist pedagogy derived from the constructivism theory that individuals create their own new understandings based on an interaction between what they already know and knowledge with which they come into contact. Constructivism also stresses that learning is a social activity, something people do together in interaction with each other, rather than an abstract concept (Dewey, 1938; Vygotsky, 1978; Resnick, 1989). The type of learner's activity, which is at the heart of problem-, project- or design-based learning, is slightly different in each of the three models. In problem-based learning, students' activities could include, for example, identifying a problem in the intermediary environment, collecting data from the field by observations and interviews, carrying out a literature survey, formulating a solution, writing the research report and presenting it to others. In project- and design-based learning, students also conduct investigations, but the heart of their activity is the design and construction of an artifact or system that is personally meaningful to them, could be shared with others and reflected upon (Thomas, Mergendoller, & Michaelson 1999; Harel & Papert, 1991). Project-based learning is common in areas such as electronics and computer science, which emphasize the development of rich and innovative systems. Design-based learning is common in areas such as mechanical or construction engineering, which also require addressing design standards, such as the optimal use of materials and energy or coping with safety issues. Knoll (1997) shows that the beginnings of project work started within vocational education in the years 1590-1765 in architectural schools in Europe. Later, and until today, the project method became a regular teaching scheme in universities and schools worldwide, with adaptation to specific disciplines. Students prepare a project within the requirements of particular courses or as a final work at the end of school.

Teacher's role in the constructivist class

Despite wide consensus in the literature about the advantages of student-centered pedagogy over traditional schooling, educators are increasingly aware of the limitations of applying these methods within the regular school context. Kirschner, Sweller and Clark (2006) write about the failure of constructivist-oriented instructional methods such as discovery, problem-based and inquiry-based learning because the notion of minimal guidance during learning does not work for novice learners. Instructional approaches that place strong emphasis on guiding the students' learning process are more effective in the first stages of learning a new subject. Some supporters of PBL (Hmelo-Silver, 2004; Hmelo-Silver, Duncan, & Chinn., 2007; Savery, 2006) mention that it is important to tailor the scope and complexity level of assignments to students' prior knowledge and skills, and provide instruction and support in order to reduce the cognitive load and enable students to learn in a complex domain. For the implementation of PjBL and DBL in engineering, the teacher is also required to prepare the technical infrastructure for students' work, for example, computers, tools, materials and measuring devices for the construction of electronic or mechanical systems.

CONCLUSIONS

Many countries worldwide place great importance on teaching science, technology and engineering in the educational system, from kindergarten to high school. In this article, we have ad-

dressed three educational approaches, problem-based learning (PBL), project-based learning (PjBL) and design-based learning (DBL, which may be suitable for teaching science, technology and engineering for children. We hope that becoming familiar with these teaching methods will encourage educators to integrate them into teaching science, technology and engineering in schools.

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Instructions for Authors

General

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3. Manuscripts should be in Hancomsoft or MS Word, on A4 size paper, 12point Times New Roman font or equivalent, double-spaced, with standard margins (about 1 inch) on all sides. Fancy typefaces, italics, underlining, and bolding should not be used except as prescribed in the APA guidelines.

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- Each table should be placed on a separate sheet.
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