International Society for Problem-Based Learning
Halla·Newcastle PBL Education and Research Center

38 Halladaehak-ro, Jeju-si, Jeju Special Self-Governing Province, 63092, Korea

Tel: +82-64-741-7430 Fax: +82-64-741-7431

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## Aims and scope

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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The International Society for Problem-Based Learning
Halla•Newcastle PBL Education and Research Center
38 Halladaehak-ro, Jeju-si, Jeju Special Self-Governing Province, 63092, Korea
Tel: +82-64-741-7430 Fax: +82-64-741-7431 E-mail: jpbleditor@gmail.com

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Journal of Problem-Based Learning

# Editorial board

Journal of Problem-Based Learning

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# Learning Outcomes for Contemporary and Future Practice: Are We There Yet?

Editorial

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Margaret McMillan
School of Nursing and Midwifery, University of Newcastle, Australia

Penelope Little
School of Nursing and Midwifery, University of Newcastle, Australia

Corresponding author:
Margaret McMillan
School of Nursing and Midwifery, University of Newcastle, 66 Rickard Street, Bateau Bay, NSW 2261, Australia
Tel: +61-408-431269
E-mail: margaret.mcmillan@newcastle.edu.au

Changing paradigms in education and practice are generally, but not always, evolutionary in nature - ideas are developed and expanded upon within preferred curriculum designs. While practice-based curriculum development is influenced by ideology and culture, principles around maintaining close alignment between education and practice remain. In learner-centred learning for the professions its also all about keeping the focus on the learning outcomes for students. However, any choices in learning activities are strongly influenced by patterns of disease, professional standards, policy ie, around scope of practice, regulations for the various professions, changing population demographics, advances in health service and educational technology and often the personal styles and preferences of academics.

One revolutionary development from the 1980s was the emergence of e-Learning. There is a clear continuing trend towards more self-direction in learning (SDL), especially since the uptake of technology-supported access to learning activities beyond the traditional classrooms. This greater autonomy in learning became more evident from the time of the introduction of computer-assisted learning in the 1980s-90s resulting in a change of pattern in how students accessed resources: One could see students' patterns in accessing resources which became more accessible as e-resources evolved. As the movement towards greater online and blended modes of program implementation grew, it was evident that rich resources for stimulus material was available; students were less reliant on teacher-centred resources. However, it was also clear to curriculum reviewers that sometimes there was a lack of translation of elements of curriculum philosophy and methodology into the learner-managed processes; appropriate scaffolding and directions for students were often limited or even missing.

It is essential for students to take responsibility for their own learning. By modelling collaborative and group-based activities, similar concepts can be transferred to facilitation of appropriately co-ordinated plans for self-care by patients/clients. However, learning activities must be structured to facilitate not only students' ability for SDL but other learning outcomes such as greater depth in thinking, an orientation to ethical, lawful and professional behaviours, skill in determin-

ing the worthiness of evidence, heightened awareness of the rights and needs of clientele.

Becoming a health professional occurs through being able to *think and act like*

- a nurse or a physiotherapist, an occupational therapist, a medical emergency care worker or a doctor. How professionals conceptualize practice shapes what they learn from practice: Students should be encouraged to observe practice and explore alternatives when tensions arise between the ideal and actual practice. It is the skill in enquiry processes (the thinking about) that enables students to develop meaningful knowledge about their professional practice.

From our experience, most curriculum documents reflect a commitment to

1. Enquiry processes involving critical thinking and
2. Reflection on learning

However, closer scrutiny of implementation shows that these two essential elements of programs require ongoing development as each new student cohort begins a journey towards *becoming confident and competent professionals*.

Curriculum developers often ask 'what options do we have for curriculum renewal that achieves greater student engagement?' 'How do I manage an online classroom?' Irrespective of modifications to stimulus material, there is a constant need to ensure that health professional education reflects flexibility for teacher's creativity in causing students to examine novel and messy situations that focus on

1. encouraging students to view situations from a range of perspectives
2. the learners' needs through the use of authentic stimulus material, allowing them to embrace the concepts and activities essential to practice
3. challenging students to question and justify the practice and challenge their values and beliefs
4. emphasising the ability to think about their discipline
5. focussing on performing actions to manage situations
6. challenging students to continue with lifelong learning and professional development based on evidence-based practice.

In response to the question 'Are we there yet?' the answer is embedded in the integrity of one's interrogation of the curriculum blueprint. Good governance of curriculum will ensure consistent use of an acceptable philosophy. Ongoing interrogation of implementation efforts will lead to appropriate refreshment and/or renewal of stimulus material that reflects contemporary clinical practice.

So what of the future? Drivers of curriculum development include the need to consider the notion that the health and higher education workforces and workplaces are changing dramatically. These changes are also influenced by larger student enrolments because of more accessible mass education and advances in technology. In the academic workplace there is a need to demonstrate greater clarity around the complementary but different roles of the academics and clinicians, technicians and administrators; they are inextricably entwined in the contemporary environment but academic judgment is the domain of the educator. A vast range of potential stimulus material is readily available given advances in technology, but those involved in governance processes have a responsibility to encourage users to determine the relevance and worthiness of resources. While students are demonstrating greater self direction in learning activities, educators need to be vigilant about the strength of enquiry and reflection processes and outcomes.

Professional development of academics needs to include an understanding of their practice if their students are to achieve meaningful learning, especially when technology is involved in the expectation of enhancing learning. This should include some appreciation of theory that underpins their assumptions about learning and teaching. Greater awareness of theoretical underpinnings of learning processes can provide answers to questions such as "What type of learner does society need for the future workplace and society more generally?"

# Curriculum Design and Implementation: Resources, Processes and Results

Margaret McMillan[1], Penelope Little[1], Jane Conway[2], Annette Solman[3]

[1]School of Nursing and Midwifery, University of Newcastle, Australia
[2]Dean Teaching & Learning, Faculty of Medicine & Health, UNE, Armidale, NSW, Australia
[3]NSW Higher Education Training Institute Adjunct Professor, University of Technology, Sydney, NSW, Australia

**Purpose:** To conduct critical reviews of two current health professional programs to test alignment of implementation efforts and governance processes to student, academic and industry expectations and outcomes; To make recommendations for curriculum design and implementation that optimize alignment of course/unit processes and outcomes to expectations of stakeholders.
**Methods:** Workshops and iterative processes document analysis, comparative appraisal of website program offerings, analysis of graduate survey responses, literature reviews.
**Results:** Implicit in renewal processes were intentions to align to Faculty Vision, ensure viability of offerings, improve responses to student and service needs and monitor impact of design choices on resources.
**Conclusion:** Improving alignment of strategies with curriculum design were reliant on good governance of implementation, management of resources supporting learning. Review processes require collaboration between reviewers and members of academic units, consideration of extent of achievement of shared expectations around learning and teaching activities and appraisal of realistic expectations of curriculum.

**Keywords:** Curriculum review; Student-centred learning; Academic workloads

Original Article

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Corresponding author:
Margaret McMillan
School of Nursing and Midwifery, University of Newcastle, 66 Rickard Street, Bateau Bay, NSW 2261, Australia
Tel: +61-408-431269
Fax: +61-243-494538
E-mail: margaret.mcmillan@newcastle.edu.au



## INTRODUCTION

Societal expectations demand graduates from contemporary higher education who have attributes consistent with the needs of informed citizenship and professional practice; this entails the capacity to apply critical thinking to a range of contexts. The purpose of the latter centers on the ability of graduates to embrace and enhance outcomes relevant to society and their professional practice. Any review of published graduate attributes in Australia shows common elements: Critical thinking, enquiry/problem-solving, communication skills that facilitate constructive negotiations around change, information fluency, global citizenship, professional practice. Despite the opportunity to capitalize on a variety of ways of implementing these ideas, there are common elements for success in achieving these. The single most important is the need to ensure a learner-centered approach that gives the student the 'know-how' to become life-long learners as citizens and reflective practitioners.

As experienced educators ourselves the authors have participated in all aspects of curriculum design, accreditation, implementation, formative renewal, evaluation, and review. In all endeavors, over time, certain elements emerge as critical to the development of learner-centered approaches required to satisfy the required curriculum and graduate outcomes. Our particular educational philosophical approach includes the following principles:

· Learning must be context-based and reflect the complexities of the real world

- The context must reflect how the discipline informs the everyday life and/or professional practice; the students can see the relevance and thus engage more readily in the learning event
- The stimuli for learning need to be initiated with student engagement in mind; the material aims to provoke students to see alternative responses to situations thus engaging in enquiry
- The notion of self-directed, peer and facilitated learning is central to the methodology that embeds life-long learning
- Building sound communication strategies enables students to identify issues and make a constructive response that is defensible through evidence that supports improvement/change for systems and clients
- Frameworks for critical thinking and reflective practice need to be made explicit in all learning endeavors if students are to emerge as constructive contributors to society and professional practice.

While curriculum review methodologies may differ, the expression of the above principles should be evident to the review in both curriculum documents and implementation processes and outcomes. While this is our lens through which we achieve sound educational design and outcomes, it necessarily requires institutional support through appropriate governance and adequate resources (human and other) that are cognisant of student and staff workloads.

This paper centers on the authors' experience with reviews of postgraduate studies across the Australian higher education sector. However, the issues raised in two exemplars to curriculum renewal apply to a review of any curriculum development initiative. The authors suggest that both at the design and implementation stages, insufficient consideration is given to the impact of decisions on the student experience and identification of appropriate human and other resources needed for good governance in pursuit of sustainable implementation *processes, outcomes and results* consistent with the attainment of the stated graduate profiles.

## Standards for Curriculum Renewal: Expectations and outcomes

In a similar way to accreditation bodies across the world, the Tertiary Education Quality Standards Agency (TEQSA) in Australia establishes the criteria for accreditation of education providers and programs; recent renewal of standards reflected the importance they placed the student learning experience and the required resources that need to be available to support successful learning outcomes. Different professions also have standards that inform program accreditation processes. Generally, curriculum reviewers are required to respond with details of processes and outcomes since the last review in formal templates and members of other health professional accreditation panels also typically seek evidence of outcomes against those criteria.

While TEQSA and professional accreditors do not express a view on curriculum design, the focus is on all aspects of governance within approaches to implementation; choices around instructional design influence the latter. The main aims for accreditors are to ensure quality in student activities and outcomes, establish reasonable expectations around resources for academics and to promote evidence-based approaches to the management of educational processes that incorporate preparation for professional practice. A workload model is required by the TEQSA so that students are assured of adequate resources to meet the outcomes specified in the accredited program. Workload models ensure that academic roles and responsibilities are clear and development and implementation effort are distributed equitably and transparently across academic staff members. Models underpinned by established principles are now widely used across the higher education sector. These are significant in informing mutual expectations among directors within organizations, educators, program and course coordinators, and student support teams about work and work practices.

## Two cases of curriculum renewal are reported on in this paper:

*Case 1* is an Australian University offering a range of options for Masters programs, including mental health, with exit points at Graduate Certificate or Graduate Diploma Level. Like most universities, these postgraduate programs for Australian students involved online offerings with some intensive face-to-face study days. International students need to comply with regulations that include participation in on-campus offerings.

*Case 2* involved an organization that services health professional development state-wide. This organization had recently successfully acquired initial accreditation by TEQSA to offer Masters level studies (with exit points) focussed on professional preparation to respond to a range of patient/client experiences in mental health and illness.

The programs' Conceptual Frameworks were consistent with contemporary postgraduate education design for medical and other health professionals, the frequent use of blended (including online) modes of delivery, and a recognition of a need to reflect alignment to clinical practice.

## Literature review

### *Curriculum design and student learning outcomes*

Postgraduate education in health professional education in Australia has continued to grow since the 1990s. However, Sandars et al. (2015) suggest that "often the use of educational theory to inform (curriculum) design is not made explicit". They noted that the professional development of educators needs to include an understanding of their practice if they are to promote meaningful

learning, especially when technology is involved in the learning processes. An educational theory they add, can provide answers to the question "What type of learner do I want to develop?"

Reviews of suites of Australian online offerings in the health professions across Higher Education providers show a consistent trend towards rationalization of course/subject offerings. The need to consider stakeholders' returns on investment in the postgraduate study was also apparent;Ng et al. (2014) focused on educational outcomes. They used Barr et al. 's (1999) Evaluative Framework to begin their exploration of student perceptions of educational experiences:

- Learner's reaction - the learners' views of their learning experience and satisfaction with their training and education
- Changes in attitudes and perceptions – towards patients and their carers
- Acquisition of knowledge and skills - the acquisition of concepts, procedures, and principles of working with specific patient groups, and the acquisition of critical thinking and problem solving, intervention skills, and team working skills
- Changes in behavior - implementing Learning in the workplace, as a result of changes in attitudes and perceptions, or the application of newly acquired knowledge and skills.
- Changes in organizational practice - wider changes in health care delivery
- Benefits to patients and carers - improvement to their health and well-being

Ng et al. (2014) queried the extent to which there is any evidence of changes in attitude or measures of change in practice but some evidence of knowledge and skill acquisition as a result of the completion of postgraduate studies. Online information available on exit surveys of Australian students shows a trend for around 80% of graduate satisfaction with their study experience irrespective of place of enrolment or enrolment numbers (Quality Indicators for Learning and Teaching – QILT 2016). However, enrolment figures, time for completion, and attrition rates also warrant careful consideration; these figures are not readily available to the public. It is also important to note that these data sets on graduate satisfaction do not consider the intent expressed in program objectives against outcomes consistent with the needs of professionals within actual practice.

### E-Learning and impact on educators

Kirkwood and Price (2014) undertook a literature review around the term e-learning; the concept subsumes both the application of information and communication around both learning and teaching strategies. They suggested that often the wrong questions about the value of online versus face to face learning questions are posed and recommend asking: "How can we design technology that enhances learning, and how can we measure that enhancement?" The answer to this question is more likely to focus on the things that add value to the learners' experiences while at the same time identifying how to innovate rather than merely sustaining old practices in a technological environment: "Many of the studies reviewed concentrated on the means of replicating and supplementing existing teaching". The aim of enhancing learning and achieving transformation through the use of technology is often not fully explored. This can make academic activities more complex without a satisfactory return on investment.

One can see from a survey undertaken by Henderson et al. (2017) that digital technologies are now a central feature of the student experience of higher education. However, Englund et al. (2017) suggested that "teachers' conception of and approaches to teaching are central for the successful implementation of educational technologies in higher education". In their research, the senior teachers experienced the most difficulty in adapting to this change. Less experienced teachers had fewer preconceptions of teaching responsibilities and thus were more likely to embrace innovation and be more student-centered; the transformational potential for educational technology, therefore, might be limited without appropriate professional development.

Mimirinis (2018) looked more closely at academics' conceptions of e-assessment. While assessment is recognized as a major driver of student learning and higher education institutions have more recently moved towards the use of more standardized assessment processes. In part, this has arisen because of the need for mechanisms to deal with the re-use of material in the online environment, ie, plagiarism and the need to be assured of the authenticity of the students' work. Referring to assessment literacy among academics, this author discusses issues of fairness, consistency, storage, and quality assurance processes. There was nevertheless a belief that technology could enhance the likelihood that assessment equates to learning.

Delgaty (2013) undertook a meta-analysis of e-learning involving health care professionals, describing a successful online initiative from the student perspective but involving an arduous path for academics; she noted the failure of the literature to describe elements of context. The main difficulties she described were experienced by academic, technical, and administrative staff — issues centered on the time involved in the curriculum implementation, particular responsibilities, and distribution of labor. Her research examining time spent by staff – analysis of email traffic, self -reported work logs, and web analytics resulted in a recommendation to look more closely at the nature and levels of guidance needed around workload patterns and the use of resources. There were tensions in her experience between 'top-down e-learning strategies' and 'bottom-up' creativity and innovation. Recommenda-

tions included a careful appraisal of the timing of desirable support interventions, investment in training for academics to focus on their role when reliant on e-learning. Consideration of both academic and administrative issues and being vigilant about technical support. While Delgaty's team were changing their model of learning, they also needed to change their model of working.

Henderson et al. (2017) note that from a 'logistical' perspective, the outcomes for students involved in e-learning are positive, but the 'transformation' of elements of the teaching and learning experience is not substantial. Survey responses suggest students are making good use of technologies: i) The Learner Management Systems were valued – technology assisted with organization and management of studies, staying on track, keeping up to date ii) there was greater flexibility in time and choice of places of study iii) time saving arose from capacity for revision and review, viewing information from multiple perspectives and ease of access to resources. These findings relate to outcomes that reflect greater autonomy and independence and self-direction in learning. However, Henderson et al. (2017) suggest there are numerous expansive, challenging, empowering, and enlightening ways that technologies could be used. This might require more thought be given to institutional practices and expectations if more active and participatory educational outcomes are to be achieved.

**Workloads**

Mundt (2009) made a critical point over a decade ago when she wrote:

faculty members and administrators have not reached agreement about what constitutes an appropriate workload. This statement reflects the essence of the academic workload problem and highlights the tension that exists between individual and organizational goals. Faculty members and administrators must come to a collective agreement about the relative value of different activities and the allocation of resources to achieve outcomes at the macro level as well as at the individual level.

This challenging situation persists. However, when administrators and academics have attempted to put agreed principles into a model that reflects academic scholarly efforts (Cohen et al., 2009), there is a risk of creating a system that is excessively detailed. Utz (2009) suggested that academics should celebrate the flexibility implicit in the work of teaching, research and service. Nevertheless, in 2015, Bezuidenhout reported on the changing academic roles and functions and resulting workloads, noting the demands of curriculum renewal, the potential to make oneself available over 24 hours, the demands for student support and changes in staff to student ratios; these factors it was argued have impacted academic freedom. She makes the point that there is a difference between the quantitative and qualitative elements of monitoring workload.

Acton et al. (2015) focused on increasing involvement in simulated learning situations in medical education and acknowledged the power of the innovations in this area, especially for the learner. They argued however, that simulations increased the time commitment of medical faculty and proposed strategies for compensation.

Cook and Ellaway (2015) also examined medical education and recommended use of the Stufflebeam's CIPP (Context, Input, Process, Product) model of evaluation following a needs analysis at the formative stage of innovation. This, they said, might help to identify the significant issues around the uptake of technology-enhanced learning approaches. However, understanding what is 'enhanced' through the use of technology warrants consideration.

Schneckenberg (2009) highlighted expectations for academics to play a major role in innovation efforts, especially those involving the uptake of information technologies. This is not unreasonable, for example, in the cases involving health professional education described here, where there are demands in the workplace for information fluent health service personnel. However, they cautioned that there are habitual traits evident in an academic profile and "long-standing cultural values" that impact on motivation and levels of engagement with e-learning strategies. Haggerty (2015), focusing on four applied science degrees, suggested that academic workloads are affected by many variables, and thus it is difficult to measure these in isolation. She noted that new educators had limited access to professional development during their orientation. The latter, when available, focused on technological aspects and failed to deal with the pedagogy in e-learning practices. This lack of preparation increases workload and thus is time consuming, given that it adds to the complexity with any real appreciation of what needs to happen.

## METHODS

Both case reviews involved iterative processes reliant on emergent themes from literature reviews, outcomes of participation of academic unit personnel in workshops, data from focus groups, interviews with key informants, and surveys that informed an appreciation of graduate experiences.

Curriculum reviewers and developers began by considering their assumptions and perceptions of their professional experiences around contemporary education and practice. Implications arising from the contemporary literature and data from across the sector (including websites) also informed the direction for processes of review.

Staff assumptions and perceptions will always influence subse-

quent actions around efforts for curriculum renewal or redesign; processes around program implementation and clarity about roles and functions of those involved in curriculum development and implementation also needed to be made explicit. Ultimately any redesign in an ideal world should contribute to agreed educational outcomes, efficiencies in processes, the achievement of realistic workloads, and accommodate the complex and multi-faceted variables that influence student and staff members' workloads.

## RESULTS

The two case studies achieved a high level of congruence with the principles outlined above. Both needed to review their design and delivery to achieve greater focus on for learner-centered learning in a way that was not limited only to choice and flexibility for students. Students need to be recognized as adult learners with professional experience.

There was clear evidence from the websites and literature, documents on program offerings, data from workshops and focus groups of

- recognition of a need for renewal of designs and rationalization of the range of courses or units offered in postgraduate studies in mental health across the higher education sector in Australia,
- an increasing trend for blended learning involving more sophisticated online Learner Management Systems,
- curriculum design and models of care increasingly reliant the online environment that puts the consumer (client or student) at the center of care and educational aspirations for greater integration of processes and practices,
- an exploration of the macro factors that drive curriculum development and implementation and the impact on workload:
  Contextual factors; profiles of potential students; profiles of staff – the experienced (often clinicians) but traditionally oriented versus information fluent, younger academics; members of both groups are often less well appraised of pedagogy
- consideration of the place of all health professionals in contemporary contexts and care and subsequent identification of a suite of abilities applicable to more integrated educational offerings
- the potential for postgraduate studies as educational preparation for more advanced practice and application of similar offerings to a range of health service personnel
- a search for answers to the question that clinicians might ask: Why study further? Why enroll in this particular program? Answers should lead to consideration of the potential impact on future student numbers and program offerings
- emerging patterns in e-Learning impacting curriculum design and implementation: Perceptions of outcomes – personal, professional and workplace: Clear descriptions of academic, administrative and technical roles and functions
- implications of contextual factors for demand for resources and staff workloads: This was seen to be impacted by organizational vision and strategy, curriculum design, patterns of enrolment, nature, and extent of integration of concepts, approaches to assessment, implementation of online initiatives, clarity in description of roles and functions in academic/administrative/technological activities around curriculum development and implementation.

Emergent themes within the results of review processes undertaken by the organizations' personnel were used by the external reviewers: These centered on clarification of strategic intent, implications for choices in curriculum structures that inform and are informed by conceptual frameworks, consideration of the impact of choices on curriculum implementation, clarification of roles and functions across academic, administrative and technical responsibilities. These are now elaborated upon.

### Strategic Directions

Examination of stated organizational intentions about the future need to be made explicit so that governance processes for curriculum implementation also reflect the achievement of all elements of vision and mission statements. At an appropriate time within the accreditation cycle, there is an opportunity to revisit earlier decisions that have impacted the current programs and their implementation. So often, what follows curriculum development is a period of disruption eg, as a result of technological innovation creating demand for intense activity around course development. Mid-cycle is timely for careful reconsideration of earlier decisions that impact subsequent decisions around the way forward.

The conceptual framework/s should reflect a particular strategic strength of the education provider but also the reality of contemporary integrated practice; significant strategic strengths provide an opportunity for course offerings being offered in common across a range of disciplines. This also facilitates the better use of content experts that will attract greater interest in enrolling in programs reflecting advanced practice skill development in response to the needs of consumers experiencing particular symptoms. Separate reports on governance could be required to respond to specific professional accreditation requirements to ensure appropriate responses to context, application to discipline-specific roles, and details of outcomes of the practice-based assessment.

### Curriculum Structure

Any existing or proposed health professional postgraduate education design, including exit points and modes of delivery, need to reflect alignment to contemporary clinical practice. The impact of choices around the design of opportunity for students to 'specialize' will impact on the total number of course units on offer. The complexity of administration and teaching activities means that programs will not be sustainable unless there are viable student enrolments. Critical decisions should, therefore, include resource implications of using particular curriculum frameworks and structures.

### Curriculum Implementation

Organizational strengths in online delivery need to be extended to ensure the provision of course offerings consistent with higher education standards, professional development initiatives, and student expectations. This could be especially useful for the cost-effective development of fixed resource sessions eg, Lectures provided by content experts, that are often problematic because of the availability of personnel and time constraints. Use of other institutional resources included professional development on blended and online learning initiatives eg, Professional Development Programs that model facilitative styles and contemporary learning initiatives or Graduate Certificates in Tertiary Teaching offered by Learning and Development Centres.

### Administration and Teaching/Learning support

The extent to which administrative support is aligned to student or academic needs in a manner that is efficient and effective was interrogated. The functions identified in position descriptions while comprehensive, sometimes involve elements of duplication and redundancy.

Redefinition of the academic support roles and functions need to be re-aligned to administrative roles and functions informed by a student-focused needs assessment across the academic calendar eg, Admissions and Student enrolments, progression and attrition; Assessment; Learning and development referrals for Academic decisions; Information Technology referrals, General Enquiries.

Academic, administrative responsibilities need to be clearly defined and separated from the support officer's responsibilities. There was also evidence of a blurring of academic staff and support personnel responsibilities. Ultimately, the academic must be responsible for student learning activities and assessments.

### Levels of Governance

Following any decisions on curriculum renewal, processes and responsibilities for levels of responsibility for matters of governance need to be clarified before decisions on load attributed to effort: The educational leadership and governance roles, program, course/unit co-ordination roles, and responsibilities need to be clarified and boundaries maintained.

The contractual agreement at enrolment between the student and the institution should be consistent with the accredited program, and therefore governance efforts must ensure its consistency with the appropriate award levels and internal consistency among objectives, learning events, and assessment. Therefore, the authority for decision-making must be apparent.

## CONCLUSIONS

In order to make decisions on whether to refresh, renew or abandon particular elements of a program, curriculum developers also need to consider both the impact of their decisions on achievement of the learning outcomes reflected in the graduate profile and the extent to which those decisions are informed by the principles outlined above. Their approach to the management of staff members' workload associated with learning and teaching and other scholarly activities also warrants careful consideration with the sustainability of preferred design in mind. This requires consideration of the required human and material resources attributed to academic, administrative, and technical elements necessary for sound, sustainable program implementation. In an era of greater access to higher education, greater cultural diversity within student and health service clientele, technology-enhanced education and practice, and an orientation towards practice-based curriculum design, thoughtfulness about sound design and governance of curriculum implementation is warranted.

To conclude, the reviewers are expected to make recommendations for quality assurance and quality improvement and consider the sustainability of existing and future resources that support students' experiences.

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# Priority Analysis of PBL Evaluation Score using AHP

Mincheol Kim

Department of MIS, Jeju National University, Republic of Korea

**Purpose:** The aim of this study was to improve the objectivity of an assessment scale by applying the Analytic Hierarchy Process (AHP) methodology with the learners themselves determining the weightings against the importance of evaluation factors.
**Methods:** By analyzing assessment results of 20 respondents, calculations of the relative importance of the PBL evaluation factors were made.
**Results:** The PBL rating scale factor (0.450) was the most important factor in the first criterion. As a result, participants in the PBL class were weighted more heavily on the evaluation of the members of the team. Within the evaluation of team members using the second criterion, they were interested in problem solving activities (0.287) and self-direction (0.283) -these were highly weighted. Finally, in the relative importance (global weight) of all the measures (12) in the secondary criterion, problem solving activity (0.129) was found to be the most important activity in applying PBL processes.
**Conclusions:** As a result, it is possible to increase the satisfaction of the learning effect by setting the weight of the PBL evaluation scale. Hence, this educational design based on creativity has the advantages of PBL in that the students become more involved in class by engaging themselves creatively and actively, and the university can naturally contribute to nurturing creative talents.

**Keywords:** Problem-Based Learning (PBL); Evaluation; Analytic Hierarchy Process (AHP); Priority analysis

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Corresponding author:
Mincheol Kim
Arail-dong Jeju National University,
Jeju Daehak-ro, Jeju-si 63243, Korea
Tel: +82-1-3466-9377
Fax: +82-64-724-3138
E-mail: mck1292@gmail.com



## INTRODUCTION

In the era of the 4th Industrial Revolution, it is socially demanded to cultivate creative talents based on information based society and knowledge based society. In order to cultivate these talents, education based on creativity is being expanded (Kautsar & Sarno, 2019). There is an advantage to developing small groups with problem-based learning (PBL) problems to develop teamwork, leadership, communication and communication skills, creative thinking and critical thinking, especially through group activities (Lozano et al., 2015;Sipes, 2017;Woods, 1996). In other words, this approach allows students to experience the creative process of PBL problems through voluntary learning activities and experience the process of actively solving existing knowledge and new knowledge (Kolmos, De Graaff, & Du, 2009).

Specifically, classes through PBL are naturally evaluated in the course of identifying students' activities and confirming whether they acquire the necessary knowledge in the PBL problem solving process, unlike the middle and final exams commonly used in general lectures (Jang et al., 2013). The evaluation of individual activities during the learning assessment should be performed, as well as group assessments of small group activities. It includes a variety of evaluation methods such as oral presentation evaluation, detailed evaluation, report evaluation, team portfolio evaluation, exhibition evaluation, team peer evaluation, and attendance for the PBL team

performance evaluation of the PBL team. This PBL leads to more subjective judgments than to test evaluation in general lectures although all performance evaluation are subjective (Prihatiningsih & Qomariyah, 2016). Therefore, there is a dissatisfactory aspect of the students' evaluation. Therefore, for a more objective assessment in PBL classes, it is necessary to clarify the evaluation method at the beginning of the class and to make the evaluation ratio among the evaluation factors by the students themselves. Finally, this study intends to analyze the results of introducing a method of calculating the relative importance of these factors.

## METHODOLOGY: PBL USING AHP

PBL method can be used for real-world problems seen in real life and motivation and interest can be gained by learning related problems. In the end, the greatest advantage of the PBL method is that it is not a lecture by a professor, but a learner-centered learning in which students have to solve problems themselves (Barrows, 1985).

In general, when grading the PBL, the relative importance of each assessment factor for class participants is calculated equally. However, as more detailed and specific evaluation, students will be able to improve their class satisfaction by giving them the relative importance of the evaluation factors in advance. Therefore, this study will be based on volunteer surveys of students in order to calculate the importance of evaluation factors. These surveys were conducted by ZU et al. (2011) will apply the AHP (Analytic Hierarchy Process) research method used in the PBL evaluation.

AHP used in this study is one of the decision support methods based on multivariate evaluation criteria for multiple alternatives. It was first proposed in the paper "The Analytic Hierarchy Process" published by Thomas Saaty in 1980. In particular, AHP has been widely used in the field of decision making due to the simplicity and clarity of theory, simplicity of application and versatility, and research on theory has been actively conducted. These AHPs can classify the problems by layering and segmenting the problems themselves, and it is possible to classify the problems in a hierarchical manner, to eliminate the error information through the consistency test of the pair comparison, and to ensure the reliability of priorities due to the objectivity and reliability of the importance of the elements. In particular, logical consistency can be verified if there are three or more comparisons against a specific criterion. If the inconsistency ratio is higher than 0.1, the decision of the respondent (decision maker) is considered to be lacking in logical consistency (Saaty, 1980).

In this study, this study apply the following procedure.

Typically, decisions made through AHP are generally subject to the following six steps (Saaty, 1980).

The first step is to define the problem and derive the decision factors. At this stage, this study clarify the problem (purpose) through brainstorming, literature survey, expert opinion gathering, and derive judgment criteria and alternatives. It also sets the "musts" criterion as a criterion that must be met and removes alternatives that do not meet the "musts" criterion. For example, eliminate alternatives that cost more than a given budget. In this study, each evaluation factor will be investigated and listed based on existing studies. For example, Kang In-ae (2003) presented four major evaluation papers: PBL self-evaluation, peer evaluation in PBL team members, PBL team evaluation, PBL team evaluation.

The second step is the decision-making model. It builds a decision model in the form of a hierarchy that includes all of the decision-making elements such as analytical objectives, criteria, sub-criteria, and alternatives. Other factors (actors, scenarios, etc.) may be included. At this time, it is recommended that the number of objects to be compared with respect to the same criterion is not more than nine. For example, the number of the highest judgment criteria to be compared with respect to the objective is not more than 9, or the number of the lower judgment criteria to be compared with the specific highest judgment criterion is not more than 9. This research will model the relationship between the factors by classifying the evaluation factors determined in the first step. In the example of the previous step 1, the personal evaluation and the team evaluation can be classified and modeled.

The third step is the evaluation of factors through pair comparisons. This means that each decision element is assessed through a one-to-one pair comparison of how important or preferential to the parent element is (ie, a higher decision criterion for the objective, a lower decision criterion for the higher decision criterion, To evaluate the alternatives). Use as many factual data as possible and assess qualitative parts of the problem using knowledge, experience, and intuition. In this study, the AHP questionnaire will be used to make a relative assessment among the factors.

The fourth step is the verification of logical consistency. The next step in analytical thinking is to judge how logical decision consistency of decision makers (or survey respondents) is. Improves logical consistency by identifying inconsistency ratios for evaluation results for elements through pair comparisons. As a result of the experiment and the verification, if the inconsistency ratio exceeds 0.1, it is judged that the inconsistency of judgment exceeds the acceptable level. Therefore, if the inconsistency ratio is higher than 0.1, it is necessary to review the result of the pair comparison again and to modify the judgment of the illogical part. This study discusses the results of survey responses and improve the reliability of the analysis results by maintaining consistency.

The fifth step is the integration and group judgment. It inte-

grates the evaluation results of the elements through pair comparison to derive the importance between the judging criteria and to derive the optimal alternative or to derive the priority and importance between the alternatives. For this purpose, the final priorities (importance or priority) of the elements are derived from the eigenvalues of mathematics from all pairwise comparison matrices. In the case of a large number of decision makers, the opinions of all decision makers are integrated. At this time, the consensus of multiple decision makers utilizes the geometric mean value. In some cases, only the importance of the criteria is determined without any alternative.

In this study, this study will present the result of applying the students' consensus to the class with the importance score of each evaluated factor.

## ANALYSIS RESULTS

### 1. Research scope and data collection

The temporal range of this study will be based on the research procedure starting from the base year (2019). The spatial range of this study is the PBL class operated by the researcher, and the overseas case is set as the spatial range to grasp the international flow in order to investigate and collect the related literature review in advance. The importance of the evaluation factors in this study will be based on the voluntary questionnaire of the learners, so students will be satisfied with the assessment items and more objectivity. This analysis will lead students to a consensus and apply them in practice before class. In other words, it can be used to derive the results of this analysis and apply it to the actual PBL class, and to improve the aspect of the class evaluation through feedback.

While explaining the research ethical aspects in advance, the data used in this study consisted of a total of 20 copies focused on the postgraduate reseachers, lecturers and interested respondents in the PBL-related class (2019), and the final data were analyzed.

The items in the questionnaire presented in this study were applied excerpts from the study of Kang (2003) (see Table 1). The first criterion presented in table 1 was classified into three categories: self-evaluation, team-member evaluation, and team evaluation. Four criteria were set as secondary criteria.

### 2. Empirical results

The inconsistent data of the collected responses were corrected by Expert Choice (AHP software) and final analysis was conducted. The inconsistency here refers to the level of reliability of the response result. The consistency of the results obtained through the AHP analysis is confirmed by the consistency ratio (C.R.). The consistency ratio derived from this study is considered to be lacking logical consistency when it is higher than 0.1.

Table 2 shows the relative importance results of each of the measured primary and secondary evaluation scales.

Table 2 shows that the most important factor was the team member evaluation (0.450). Followed by self-evaluation (0.351) and evaluation on other team (0.199). As a result, participants in the BPL class were more weighted in the evaluation of the members of the team. On the other hand, this study has a low weighting on the evaluation on other team, which is judged as a possibility that the opportunity to evaluate the team is small.

Within the evaluation of the team members in the secondary criterion, they were interested in problem solving activities (0.287), and self-directed learing (0.283) were highly weighted. However, it is necessary to pay attention to the fact that there are few differences among the four secondary criteria. In addition, it

**Table 1.** Questionnaire evaluation items

| Aim | Primary criteria | Secondary criteria |
|---|---|---|
| Assessing the importance of PBL evaluation items through a survey | Self-evaluation | 1. Did you actively participate in problem solving activities? |
| | | 2. Did you faithfully present the learning outcomes? |
| | | 3. Did you collect and use various information? |
| | | 4. Did you conduct self-directed learning? |
| | Team member evaluation | 1. Did team member actively participate in problem solving activities? |
| | | 2. Did team member faithfully present the learning outcomes? |
| | | 3. Did team member collect and use various information? |
| | | 4. Did team member conduct self-directed learning? |
| | Evaluating other team | 1. Has other team provided a lot of information related to the problem? |
| | | 2. Did other team collect and analyze diverse learning materials, provide rational grounds and reasons for comment, and report the learning results in an easy to understand way? |
| | | 3. Did other team participate with the most interest in learning? |
| | | 4. Did other team work hard to prevent others from interfering? |

**Table 2.** Relative importance and priority for each criterion

| Primary criteria | Relative importance* | Primary ranking | Secondary criteria | Local –relative importance* | Local Ranking** | Global-relative importance* | Global Ranking** |
|---|---|---|---|---|---|---|---|
| Self-evaluation | 0.351 | 2 | Problem solving activities | 0.248 | 2 | 0.087 | 6 |
| | | | Learning outcomes | 0.223 | 4 | 0.078 | 8 |
| | | | Various information | 0.246 | 3 | 0.086 | 7 |
| | | | Self-directed learning | 0.283 | 1 | 0.099 | 4 |
| Team member evaluation | 0.450 | 1 | Problem solving activities | 0.287 | 1 | 0.129 | 1 |
| | | | Learning outcomes | 0.273 | 2 | 0.123 | 2 |
| | | | Various information | 0.220 | 4 | 0.099 | 4 |
| | | | Self-directed learning | 0.221 | 3 | 0.100 | 3 |
| Evaluation on other team | 0.199 | 3 | A lot of information | 0.246 | 3 | 0.049 | 11 |
| | | | Diverse learning materials | 0.338 | 1 | 0.067 | 9 |
| | | | Interest | 0.310 | 2 | 0.062 | 10 |
| | | | Interference | 0.106 | 4 | 0.021 | 12 |

*Overall Consistency Ratio < 0.1.
**Local (The weights of the measures in each primary criterion), Global (All the values of each secondary criterion).

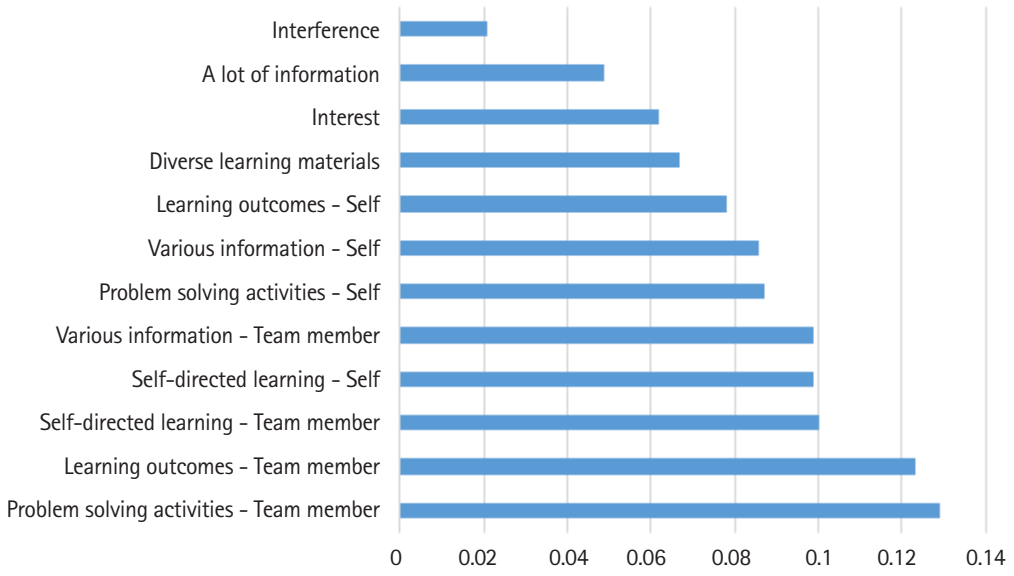


**Figure 1.** Relative priority by all rating scales.

was shown that the interference (0.106) scale is a meaningless evaluation factor in the evaluation of the team, so it is meaningful to exclude it when applying PBL in the future.

Finally, in the relative importance (global weight) of all the measures (twelve items) in the secondary criterion, the problem solving activities (0.129), learning outcomes (0.273), and self-directed learning (0.221) were the most important activity in order.

The above results in Figure 1 shows the relative priority (weights) of all the factore (scales) in a graph.

## CONCLUSIONS

This study analyzed the cases using PBL for participants of class in Jeju National University, South Korea. In this study, PBL teaching method is used to determine self - directed learning and problem solving ability. The purpose of this study is to improve the objectivity of the evaluation by applying the AHP methodology to the learner in setting the importance of the PBL evaluation scale. The results of this analysis can be summarized as follows.

Firstly, the evaluation scale is a very important satisfaction factor while learning using the PBL learning method. However, most

evaluation scales are simply measured on a 5-point scale, making it difficult to meet the individual needs of each learner. However, as in this study, the AHP methodology through learner 's agreement will be an incentive to increase the satisfaction level of the PBL learning method.

Secondly, PBL evaluation scale factors In the first criterion, team member evaluation (0.450) was the most important factor. As a result, participants in the PBL class were more weighted in the evaluation of the members in the team. Within the evaluation on the team members in the second criterion, they were interested in problem solving activities (0.287), and self-directed learning (0.283) were highly weighted. Finally, in the relative importance (global weight) of all the measures (12 items) in the secondary criterion, the problem solving activities (0.129), learning outcomes (0.273), and self-directed learning (0.221) were the most important activity in order. Although it is limited to this case, applying this methodology will allow instructors to reflect on their lecture plan when using other PBL lessons.

Thirdly, if additional items are inserted by the 5 point Likert scale between the whole evaluation items in the questionnaire item and regression analysis is used as the basis for applying the IPA (Importance-Performance Analysis) method on the total satisfaction scale . In other words, additional implications can be calculated by applying an IPM (Importance-Performance Analysis) based on Partial Least Square-Structural Equation Method (PLS_SEM) (Hair et al., 2016).

In conclusion, this educational design based on creativity has the advantages of PBL in that the students become more involved in class by engaging themselves creatively and actively, and the university can naturally contribute to nurturing creative talents. In particular, as in this study, by setting the weight of the PBL evaluation scale among the learners themselves, the satisfaction of the learning effect can be increased.

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# The Teacher as Learner: Professional Development Programs as Agents for Change

Penelope Little, Margaret McMillan

School of Nursing and Midwifery, University of Newcastle, Australia

**Purpose:** To provide a rationale for the design and implementation of a Professional Development Program for academics and present reflections on the process and outcomes provided by the program facilitators and participants.
**Methods:** The program methodology centres on a collaborative approach to professional development. However, the focus is on student-centred rather than teacher-centred learning approaches in a manner consistent with the ideals of practice/ problem-based learning philosophy and methodology.
**Results:** Reflective pieces provided at the conclusion of the program demonstrated that participants satisfied the criteria for leaner-managed learning outcomes.
**Conclusion:** The context and culture of the academic environment has continuously changed over the last three decades mainly given developments in technology. However, in contexts reliant on technology enhanced learning and teaching, successful on-line learning events still need to reflect a student-centred approach. In most instances professional development opportunities should allow academics the freedom to pursue answers to their own development needs.

**Keywords:** Professional development; Student-centred learning; On-line learning

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Corresponding author:
Margaret McMillan
School of Nursing and Midwifery, University of Newcastle, 66 Rickard Street, Bateau Bay, NSW 2261, Australia
Tel: +61-408-431269
Fax: +61-243-494538
E-mail: margaret.mcmillan@newcastle.edu.au



## INTRODUCTION

Australian University websites highlight commitment to learning and teaching. Frequently there is also reference to strong support for academics through professional development in pursuit of progressive and good practice, scholarly ideals in learning and teaching and curriculum development. Englund, Olofesson & Price (2017) suggested that teachers' worldviews around teaching are central to curriculum implementation involving educational technologies in higher education. The senior teachers experienced the greatest difficulty in changing. Less experienced teachers had fewer preconceptions of teaching responsibilities and thus were more likely to embrace innovation and be more student-centred. Hence the transformational potential for educational technology might be limited.

The context and culture of the academic environment has continuously changed over the last three decades mainly given developments in technology (Cook & Ellaway, 2015). However, in contexts reliant on technology enhanced learning and teaching, successful on-line learning events still need to reflect a student-centred approach; these elements have implications for academics as they strive to develop and maintain optimal learner management systems and processes. Any changes in models of learning has implications for consistent changes in models of working in a learning environment. The latter demands support through professional development that showcases the philosophy and methodology. Delgaty (2013) recommendations included careful appraisal of timing of desirable support interventions, investment in training for academ-

ics to focus on their role when reliant on e-learning. consideration of both academic and administrative issues and being vigilant about technical support. This paper describes the design and implementation of one program that has been applied in a variety of higher education contexts, using different delivery methods for groups of different sizes; these included face to face, blended learning and all on-line. Despite the different contexts and delivery methods, the educational approach is maintained through application and modelling of the principles of student-centred learning.

## METHODS

The program methodology centres on a collaborative approach to professional development; the focus is on student-centred rather than teacher-centred learning approaches (McMillan, 2017), but the teacher identifies their own learning needs. The stimuli for learning need to be initiated with student engagement in mind; the material should aim to provoke students to see alternative responses to situations thus engaging in relevant enquiry processes that meets their learning outcomes.

It is important at the outset to allow the group members as learners to identify their own learning needs. Our assumptions in this collaborative learning venture were that the participants have:

- A demanding workload and would be strategic in their approach to meeting the PDP requirements
- Some knowledge and experience of innovative student-centred teaching approaches
- Some knowledge of appropriate teaching/learning evaluation protocols and research methodologies
- Developed some insights into their teaching practice.
- An expectation that the PDP would model a student-centred approach to teaching

The participants learn about and share personal knowledge and experiences of student-centred teaching models in order to increase effectiveness as facilitators of student learning and in encouraging students to take increasing responsibility for their own learning. The approach has been applied by the facilitators to many and varied groups of academics wanting to enhance their own teaching with a stronger focus on student-centred learning. While the principles and main learning activities remain a constant, the delivery method has varied over time and circumstance.

Two examples are reported: The first a course unit undertaken as part of a Tertiary Teaching Award, delivered through three workshops, online forums and individual online facilitation; the second through three synchronous video group sessions, three individual video sessions and online facilitation both group and individual. The latter is still in progress, however, ongoing reflection by the facilitators provides insights that confirm the methodology is consistent in its potential to bring about change in the teaching approaches of academics.

### Rationale

The Professional Development Program (PDP) allows the participants to explore strategies that may be used to facilitate and enhance student learning based on student-centred methods. The program resources emerge from and capitalize on the wealth of experience from the facilitators themselves; the central concepts deriving from problem/practice/enquiry-based learning and similar student and context-based educational strategies. We hope that this article provides a framework for professional development, particularly as demands for blended on-line learning emerge.

### Program objectives

During the course the participants are encouraged to:

1. Share, discuss and critique student-centred approaches to teaching and learning focusing on particular educational needs and imperatives.
2. Select, develop and implement a student-centred intervention in units coordinated by the participants to enhance student learning outcomes.
3. Evaluate the effectiveness of implementing their proposed teaching/learning intervention/s.

### Processes and content

The participants are asked to identify areas for improvement that are of interest to them but particularly of value for achievement of optimal student learning outcomes. Therefore, the following are key aspirations for pursuit of student-centred learning as a major driver of innovation:

- Review of student-centred methods currently in use within the units
- Identification of opportunities to enhance learning outcomes for students.
- Selection of potential interventions to enhance student learning outcomes.
- Design and conduct a proposal to implement and evaluate the proposed intervention.
- A reflective practice assignment documenting insights gained from program participation

Given their appreciation of the current higher education context in Australia and the participants' workplaces, to inspire thinking around possibilities for small scale quality improvement projects,

the PDP facilitators suggested areas that might present an opportunity for development:

- Use of relevant stimulus material to provide a context for learning
- Student self-direction around learning
- Student engagement
- Enquiry and clinical decision-making
- The centrality of critical thinking
- Communication strategies
- Assessment including marking and moderation
- Other opportunities to excel as teacher/ facilitator/coordinators.

**Teaching/delivery methods**

Following consideration of the participants' commitments to their own workplace learning events and curriculum development, negotiations around PDP implementation led to finalization of a plan that would best accommodate opportunities for whole group involvement, peer interaction and individual sessions. Processes and learning activities involved video-conference sessions, online discussion and individual PDP project work. The following guidelines for completion of the PDP were provided:

1. Select either one or more of the course units you are coordinating this semester. Identify teaching strategies designed to align with student-centred learning. Identify one or more areas for enhancement of alignment with student-centred learning.
2. Areas for enhancement: Identification of your choice of project should articulate the student learning need or opportunity for improvement being addressed. Changes to teaching strategies are usually made in response to some perceived lack in student learning outcomes and a new or enhanced teaching strategy is adopted. You will need to describe and defend the selected teaching/learning strategy and consider the implications for the students and your peers as well as curriculum implementation.
3. Program/Course context: In addition to identifying the program and course of study, information about the numbers of students, place of course in program, broad aims of course and other relevant information should be included.
4. Alignment with principles of student-centred teaching: The teaching/learning strategy should be analysed in terms of its congruence with the principles of student-centred learning approaches. Each element of the strategy should be described in terms of its capacity to evidence one or more of the principles.
5. Anticipated outcomes: These may be described in terms of specific learning outcomes for students that can be evidenced in assessment and/or student evaluations. The outcomes should be attributable wholly or in part to the intervention.
6. Specific teaching/ learning strategy or intervention: This should describe the specific elements of the strategy and its implementation (i.e. the learning activity or assessment task should be described in detail). If it is a group task, you need to show what guidelines are given, numbers of group members, whether product and process are documented.
7. Proposed evaluation protocol: This identifies the specific methods of data collection you have selected to evaluate the effectiveness of the strategy and/or its achievement of the anticipated outcomes.

Following acceptance of the above guidelines, the program facilitators then provided their own principles, objectives, assumptions and rules of engagement in an effort to ensure the maximum level of collaboration among all members of the group.

The following is an overview of the principles, objectives, assumptions and rules of engagement.

**Principles**

The Professional Development Plan and its implementation allow participants to:

- Recognise the participants as professional colleagues with relevant experience and expertise
- Operate from a framework and philosophy that focuses on student-centred learning approaches and context-based learning
- Model a student-centred approach and context-based learning
- Provide appropriate activities to enable the participants to demonstrate their capabilities
- Provide appropriate feedback in a timely manner
- Model reflective practice using relevant, structured frameworks. Our objectives were as follows:

To ensure the participants were:

- Able to use their current and or proposed teaching as a focus for the learning/teaching enhancement project and thus integrate the project into their workload.
- Provided with the opportunity to interact as professional colleagues with each other and with the facilitators.
- Challenged to expand their understanding of the relationship between a specific teaching activity and student learning outcomes.
- Extended in terms of understanding of student-centred learning and teaching.
- Provided the opportunity to experience the role of a student in a student-centred approach to teaching through the PDP
- Encouraged to use some relevant frameworks for critical reflection on their practice
- Facilitated to produce a proposal for enhancement of the course unit/s they are teaching/ coordinating that could be implemented this semester or in a future offering.

Some rules of engagement for the individual sessions:

- Confidentiality is respected by both parties.
- Either party may call Time Out to discuss the process of the engagement as opposed to the content.
- Participants will take responsibility for ensuring the PDP is meeting their needs.
- Facilitators will seek feedback from the participant on the relevance of the program to the participant.
- The PDP will structure activities related to the participant's current coordination/teaching role to provide opportunities for application of a student-centred approach to teaching and learning.
- The participant will engage with agreed activities and provide feedback to facilitators.
- The schedule of individual meetings will have agenda items proposed by both facilitators and participant.
- Feedback on group sessions will be provided to participants and feedback on individual sessions will be provided from both facilitators and participant on the progress of participant's PDP.

Some rules of engagement for group sessions

- Facilitators will provide an agenda/outline of the session in advance.
- Participants may be required to prepare and present to the group some element of the participant's PD Plan or activities.
- Participants will be expected to engage with each other and the facilitators in the group sessions as peer learners and colleagues.
- Group sessions will be an opportunity for discussion, clarification and exploration.

The facilitators provided the following guidance on expectations for processes of reflection (by both facilitators and group members) that is an important part of any learning opportunity and should be both formative and summative:

Participants will be encouraged to reflect formatively on the content and process of the PD program throughout the course to better guide the implementation of the Program and ensure its relevance to all participants.

In addition, participants will be invited to complete a summative reflective piece (a Reflection on Practice) at the conclusion of the Program.

This PDP item requires personal reflection on your experience in the Program and to documentation of your insights.

Reflections could include insights on:

- Specific enhancements of teaching and learning strategies employed and their impact on student learning
- The impact of the context (challenges/enhancers) in implementing enhancements and using student-centred teaching methods
- The opportunities for enhancing scholarship of teaching in relation to your teaching role.
- Your experience as a participant in the PDP in relation to the implementation of student-centred teaching methods-Documentation of reflections should meet the following criteria:

1. Reflections include insights from a range of experiences in the PDP.
2. Experiences are analysed in terms of relevant theoretical frameworks.
3. Insights are discussed in terms of alignment with personal philosophy of teaching and learning and/or a conceptual framework of teaching and learning
4. Outcomes are discussed in terms of impact on further development of approaches to teaching and learning

## RESULTS

All participants and the program facilitators completed a summative reflection guided by criteria presented at the commencement of the program. Two pieces of reflection were provided after formal consent for publication was obtained from four participants who could be contacted for consent. The following are the reflections from one participant and the course facilitators. In addition, three emergent themes were evident in formal interactions from group and individual sessions.

**Participant from award program**

*As a student*

Having been away from a classroom as a learner for a long time, it was a struggle getting back into the student role that was expected all of us to be – an actively involved student in a teaching course! I have envisioned myself to be lost in the midst of non-science oriented colleagues. Nevertheless, I survived the first workshop and realized that I actually had something to contribute in the discussion and that my teaching experience was my greatest source of knowledge.

The first hurdle I had to get over with as a student in this course was my pre-conceived notion that science teaching cannot be and does not have to be student-centred and it would not be possible to align it with the principles of student-centred learning. Thus, planning a teaching/learning intervention was a struggle. Much more, I had the feeling that most of the course participants were also, like me, lost. During the reversal of role exercise in the first workshop, I felt that most of us were comfortable being in the learner situation but were having difficulty as facilitator and resource person - more so, myself. I got out of the first workshop not really sure of what I was going to do and not fully believing that the student-centred approach is the way to go in science teaching.

The project proposal preparation was an enriching learning ex-

perience for me because it was during this stage that I actually became convinced that I could drive my teaching strategy towards more student-centred approaches. Comments on the proposal, especially the first two drafts, were very helpful and clarified a lot of issues associated with the project implementation and evaluation. The support of my critical friend was likewise invaluable.

I am of the view that even if the group didn't have regular face to face contact with our facilitator, we were continually learning all throughout the semester. The project taught me a lot about student-centredness in teaching. It was after all a student-centred approach of learning by itself. I was involved, it was relevant to my work, it transformed my teaching.

Last Monday's culminating workshop was very rewarding. It was like the group was bonded as one, talking about each other's project, offering suggestions. I sensed that everybody was comfortably relating to student-centred teaching, gone were the apprehensions, uncertainty and the questioning looks. I myself felt that way.

My learning experience in the course is invaluable. Were the course objectives fulfilled? Definitely! I learned about student-centred teaching and much more, I applied the approach to my discipline area, I evaluated its effectiveness and finally I became convinced that this is the approach I would like to utilise for all my teaching to promote active learning. [P1 science teacher]

*As a Teacher Innovator*

The chosen project was implemented on a course that I taught for the first time utilizing a new textbook and operating under a new set-up, i.e. nine weeks of lecture instead of 12 for the same amount of materials. It was just the right time to introduce a new teaching strategy.

I sensed that, initially, the students were not so receptive to the idea of activity worksheets. While the first three 'lectorials' went well, it was a challenge to get the students to participate in the first hour. I persevered, I gave them more time, I enthused them, and finally it paid off. They warmed up to the idea and started to be more involved, they asked more questions and clarifications and longer discussions took place. Before thethree3 hours was over, they were already talking about the effect of the formative assessment to their learning. The next two weeks went very well and the lectures were never dull. It was so gratifying to see the lit faces of the students after the 'lectorials'.

All throughout the intervention, I was dealing with the conflict between course demands and time, thus, the discussion was sometimes rushed. In addition, the set-up of the 'lectorials' (all in one day, two hours followed by another hour with a one hour break in between) didn't allow adequate time for the students to process the given information. However, most of them quickly adapted to the pace of the 'lectorial'.

I am most pleased that the students, according to their SET (student evaluation of teaching) responses, actually felt that I, through my teaching intervention, (1) motivate them to extend their learning and (2) help them understand the importance of the content to their program. These are the two aspects of my teaching that I have been working to improve on and seem to be more transparent in student-focused learning strategies such as the 'lectorial'.

Central to my teaching philosophy is my strong belief that the primary regulator of students' learning and motivation is teacher-student interaction. It is my view that my positive interaction with the students contributed significantly to the success of the intervention. They were more willing to give me a chance and more willing to participate because I have established good rapport with them. I believe that in order to ensure favourable responses to any type of student-centred learning strategy, it is important for the teacher to first establish good rapport with the class. [P4, Award program]

*The Project: From Beginning to End*

I was challenged by this project! But I learned a lot from it.

I did take in what the facilitator has said during the first workshop that it is important to get the proposal right. And so I worked hard to get it right and it became my point of reference. I found that the proposal gave me focus especially during the preparation of the poster report and the analysis of the evaluation results. It was also very helpful that we were given the report criteria.

While the project took a lot of my time otherwise devoted to research, I don't regret spending the time on enhancing my teaching. I gained a better understanding of student-centred learning approaches and how I can apply them to my discipline; its implementation gave me the chance to enhance my teaching and interaction with students; the report helped me to consolidate my results. Overall, the project convinced me that student-centred approaches can work in science teaching.

Finally…The project successfully transformed me and my teaching. I don't believe that I can go back to being a 'normal' science lecturer. My 'lectorial' teaching experience has given me the motivation to make my teaching more relevant to the students' needs. I will, however, be realistic – start small and simple. Perhaps, my next project will be the use of 'lectorial' approach and formative tests in big 'foundation' classes. First year students certainly will benefit from the set-up given adequate time and proper class management. [P 4, Award program]

In a similar fashion to the participants, the consultant/s provided their reflections on the issues identified by participants and summaries of the project proposals.

*Reflection: The Facilitator of the award program*

Before providing some reflective comment I should reiterate my objectives and some assumptions outlined above in the description of the Professional Development Program

My reflections on achievement of objectives

The course met my objectives in that I believe the opportunities identified were provided to participants. The extent to which participants used the opportunities varied considerably as I would expect in any student population. My observation is that those who used the opportunities got the most out of the course. This is consistent with my experience of student-centred approaches to teaching.

All projects reflected some degree of enhanced implementation of student-centred teaching strategies. The sophistication of the strategies in the projects varied and reflected the experience of the participants in tertiary education.

*Course design and delivery*

I had designed the course so that it models my understanding of student-centred teaching and thus the content of the course is the design of the learning experiences. Some participants have challenged my assumptions about participants having some knowledge and experience of student-centred teaching arguing that as new to the tertiary sector, they had little understanding of this concept. However, all participants did have experience of student-centred teaching (e.g. as doctoral students themselves or in other contexts) and were able to contribute effectively to discussion of the principles in Workshop 1. However, some stated that they struggled to find an agreed definition and wanted some further input from the facilitator, especially in Workshop 1. While of course it is appropriate to have expert input as a learning opportunity in student-centred teaching, it should, in my view, follow some exploration by the learner. Providing a definition at this stage would pre-empt the engagement of the learner with an examination of their own assumptions and the literature. My observations were that this made some participants uncomfortable and frustrated which also reflects the experiences of their own students when confronted with student-centred teaching strategies. I have learned that while I am the object of that frustration, it is my role as facilitator to provide the direction and guidance but not pre-empt the learning.

In using a student-centred teaching approach I am mindful of the need to support students in their exploration of the learning opportunities and achievement of learning outcomes. I usually structure this support through the provision of explicit guidance and feedback on the learning activities and or assessment tasks. While guidance and feedback was provided on the project proposal, project report and final poster presentation, the group and the products would have benefited from possibly breaking down the project report into parts for earlier draft presentations. e.g. some submission of the relevant literature and conceptual frameworks. I would also require staged submissions of the reflective exercise, using specific areas and frameworks for reflection.

Regarding the assessment, I found the projects to be reflective of student-centred approaches. However, the challenge of designing implementing and evaluating a teaching enhancement project within one semester is considerable, even when attempts are made to ensure the scope of the projects is manageable. As some data collection requires ethics clearance, the projects in the main were pilots for what could be an extended study. This still makes the project requirement useful in my opinion. The posters were very effective and I hope they will be exhibited.

A great challenge for me was the use of 'BlackBoard' [online learning platform] in a student-centred teaching approach. My experience and skills are very limited and I was grateful for the input of some participants who took the initiative in filling in the gaps. I not only need more skill development in the effective use of the system, but need to think much more about how to translate to online, strategies I have used with effect in workshops to engage participants. My observations are that few participants used the online opportunities to interact with each other or with the facilitator. This is despite the fact that many participants acknowledged in their reflections that they were experiencing confusion and lack of confirmation that they were on the right track. This also seems to be a common experience of participants with their own students in online teaching. I would really like some assistance from participants as to what might have improved this area of the course.

My personal learning journey has been enriched by the challenge of working with participants from different disciplines and in different teaching/learning contexts. I am always appreciative of the opportunity to share teaching experiences with my colleagues and realize how much I enjoy the role of facilitator. Thank you for your participation and I look forward to your comments on the course.

**Emergent themes in records of individual/group interactions: non-award program**

Three major themes emerged as central issues of concern from reports from participants (facilitators and academics) on their experience of the learning processes in the non-award program ie not part of a formal Graduate Award: The value of modelling student centred-learning; the context of practice as a learning resource; and peer learning.

**The value of modelling student centred-learning**

At all times the consultants were conscious of modelling the centrality of the concept of putting the learner at the centre of

learning events; they provided their reflections on the issues identified by participants and summaries of the project proposals. Observations provided by participants indicated that the consultants' approach did not involve a high level of input of content e.g. educational theories. This was intentional with goal being to create a level of discomfort that mirrors student experiences and incites a level of 'cognitive dissonance' that ultimately promotes engagement and responsibility for self-directed learning. The stimulus for learning was the requirement for individual project proposals to involve identification of an area for improvement and then development and implementation of an intervention to address the issue.

Both the project proposal and implementation as well as the reflective practice exercise could be used in an award course as assessment activities and these essentially acted as the driver for all development activities.

The consultants elaborated on the goals for reflection on learning and/or practice and the extent which students are caused to fully explore their thinking, beliefs, feelings. It was suggested that ways to encourage meaningful reflection is to include exercises such as testing assumptions at the outset of the course unit and revisiting these assumptions after peer to peer (or group) interactions.

The consultants emphasised that it is also necessary to provide different frameworks for students to use in the reflective process. These might include theoretical frameworks; practice frameworks such as therapeutics; scope of practice, regulatory policies; legal and ethical frameworks; quality and safety frameworks etc.

By constantly questioning choices in designing learning events one can ask 'What am I actually asking the students to do?' i.e. Questioning the nature and rationale for choices around intentions for student learning should confirm the learning event as a means of active engagement and requiring application to practice.

It was noted that some programs use assessment as the major driver for all learning activities. This aligns with the evidence that students are motivated by the assessment and act strategically to meet those requirements. However, assessment should align with the content of the unit and focus on testing application to practice as well as provide clear and relevant evidence for achievement of specified learning outcomes and graduate competencies/capabilities. Percentages attributed to group tasks and ways to differentiate among individual contributions were discussed. Tasks that involve individual reflection were seen as worthy. It was noted that appreciation by students of the rationale for group work was critical.

**The context of practice as a learning resource**

Staff have a great deal to bring to the program and units through their extensive clinical experience as clinicians, clinical educators and educators. This experience is a valuable capability that could be used to ensure the relevance of the content and learning activities to the students and to provide the kind of practice-based stimulus for learning that is a key element in an instructional strategy that ensures students have a relevant context in which to interrogate and apply new learning ie the norm for traditional approaches is theory applied to practice; context-based learning suggests a Practice-Theory-Practice sequence.

In a similar way to the tenets of Work-integrated Learning, the academic workplace provides a 'stimulus for learning' that creates 'a need to know' about processes and systems that are new to the academic.

Participants expressed a sense of discomfort around an apparent set of explicit directions on project choices. The consultants suggested that 'situations' that encourage learning need to 'confront' and 'disconcert' – In this way they, like their own students are provoked to think.

There was a need to challenge long held beliefs about the value of for example face-to face sessions being more likely to lead to more substantial learning. It was noted by facilitators that like them, the students' reliance on their own life experiences and belief systems inform their responses, decisions and actions: There was a need for the facilitator/teacher to interrogate these for validity as the students pursue self-directed learning.

**Peer learning**

In a similar way to typical student-centred classroom practices, participants were encouraged in group sessions to respond to issues raised by their peers; they engaged in a high level of peer-peer interaction in both sessions and provided feedback that they valued this opportunity highly.

Encouragement of student-oriented interactions among peers, by exploring a way to embrace peer to peer learning, especially those reliant on self-direction in learning, is a worthy pursuit. This necessitated some thinking around the purpose of student on-line forums and ways to integrate other elements of the unit into the forum activities.

The academic environment was the context for learning; this provided the potential to work with peers just as one might with their own student group/s. A focus on their own work roles enabled participants to choose a 'critical friend' to test ideas around any review of current course units being delivered (taught/coordinated). For example, consideration of the value of choosing the timing of a practice scenario required investigation. In response to a query from an academic, the consultants discussed the benefits of using the scenario earlier in the unit before engagement with theory as a means of having students identify what they already know and what they need to learn in order to respond to the situa-

tion. It was suggested that participants might consider reviewing the use and placement of cases, pointing out the value of the case as the initial learning stimulus in the unit/topic as a framework for of the interrogation of the presented concepts and content. The initial response of the students to the case should then be revisited in the light of the further learning (self, peer, facilitated and expert presentation).

The consultants talked about the provision of stimulus material suited to differing professional roles and the need to cause students to engage with the situation and interact with others. They noted that it was all about 'relevance for students' and the importance of recognizing the extent to which design impacts on learning processes that are meaningful to different professional roles.

In individual sessions exploration of ideas and strategies centred on the value that derives from well designed 'group work' where students interact with each other, sessions are not recorded but the group nominee is responsible for feedback to the facilitator; this seemed particularly useful for 'asynchronous' sessions in blended learning situations involving choices in online and face to face tutorials. The advantages and limitations of peer learning activities, their purpose, mechanisms for assessment and ways to overcome perceived disadvantages were discussed.

## CONCLUSION

This paper provides an insight as well as a template for working with experienced teachers to enhance their confidence with student-centred learning. The context and culture of the academic environment has continuously changed over the last three decades mainly given developments in technology. However, in contexts reliant on technology enhanced learning and teaching, successful on-line learning events still need to reflect a student-centred approach. In most instances professional development opportunities should model a student-centred approach and allow academics the freedom to pursue answers to their own development needs.

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# A Learning Model for Software Coding Education

Geun-Hyung Kim

Game Engineering Major, Dong-eui University, Republic of Korea

**Purpose:** In this study, we review the creative problem-based learning model (CPBL), flipped learning, creativity, and the relationship between creativity and software coding.
**Methods:** Following a literature review and development and implementation of a learning model suited to the field of software coding, students (n=31) were surveyed for their perceptions of their experiences with the model.
**Results:** From the survey, we conclude that collaborative learning and additional self-directed practices in classrooms help students more deeply appreciate program concepts. However, most students still thought software coding too difficult to declare self-confidence on creative programming a code over one semester.
**Conclusion:** Today, knowing how to code software is indispensable and in a growing range, coding skills are highly valued. Software coding education has been the subject of several studies, since it is considered that the learning activities can contribute to the cultivation of students who are able to solve problems and to adapt to new circumstances or problems. The design of learning events is student-centered with the instructor taking a facilitative role in guiding student learning.

**Keywords:** Creative problem-based learning; collaborative learning; self-directed learning; flipped learning; software coding education

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Corresponding author:
Geun-Hyung Kim
Game Engineering Major, Dong-eui University, 176 Eomgwang-no, Busanjin-gu, Busan 47340, Korea
Tel: +82-10-3453-6553
Fax: +82-51-890-2265
E-mail: geunkim@deu.ac.kr

## INTRODUCTION

With the advent of convergence information, communication and digital technologies, a hyper-connected society means greater connectivity; the internet is embracing everything with person-to-person, person-to-machine and machine-to-machine connectivity. There will be an explosive increase in the amount of information and knowledge that is shared and accumulated. Technological convergence will now be more complex and mutable than in the fourth industrial revolution era, thus the extent of increases in levels of diversity and creativity that can cope with unexpected situations and solve complex problems will be significant. In other words, it will be essential to acquire new knowledge in classrooms and to be able to creatively solve novel problems through application of newly acquired concepts and knowledge.

Comprehensive three-dimensional thinking aspiring to excellence, greater adaptability, openness and communication ability will be indispensable; the economic structures in the fourth industrial revolution era will evolve to the 'inspiration' economy from the 'perspiration' economy. So, it is essential to make good use of what we have learned rather than learning a lot. Based on power to think on one's own, we should be able to personally identify new problems and suggest our own solutions to those problems: 'Know-why based creativity' may be a source of future social competitiveness.

In developed countries such as the United States and the United Kingdom, software coding education encompassing concepts and principles for programming languages and algorithms to cultivate students' logical thinking ability, self-directed problem definition and solving ability,

collaboration ability and creativity, is becoming compulsory. The valuable skill in software programming is essential to prepare for the fourth industrial revolution and to develop abilities in logical thinking and communication. The aim of software coding education should not simply focus on grammatical elements of programming language but on language to improve creativity, problem definition and solving, self-direction and cooperation abilities. Those students with sufficient programming abilities will be able to solve problems in daily life given their creative ideas and future computer technologies.

Software coding education should stimulate students to find imaginative solutions to problems when effective teaching strategies and novel learning resources are present: We provide suggestions for a flipped learning model that aims to enhance students' creativity, self-directed and collaborative learning abilities to solve real problems of daily life. To begin we review the concepts and features of creativity, then describe the proposed model and discuss its effectiveness.

## CONCEPTS AND FEATURES OF CREATIVITY

Creativity is the ability to define and solve problems and recognize new possibilities and opportunities. It is a core competence involving flexibility to deal with greater diversity and uncertainty in future society; it has been the subject of discussion in every field of society since Guilford's presentation on divergent thinking in the 1950s. He associated the concept with creativity that featured fluency, flexibility, originality, and elaboration (Sergey, 2017).

With the advent of Guilford's model of intellect, key instruments to measure divergent thinking or creativity were investigated by the early 1970s. Those interested in understanding creativity generated many definitions, disagreed over its nature and its many facets; Rhodes (1961) suggested 4Ps: Person, process, product, and press (Park, 2014). A person may exhibit his/her creativity in one of four different facets. The 4Ps represent the nature of creative persons, processes they use, products or outcomes of their efforts, the press, or environment that supports or hinders a person's creativity. Many studies have defined creativity in terms of individual cognitive ability or personality, manifestations of creativity processes, products of creativity, and the ecology harmonizing with social contexts and circumstances (Lim, 2015). Table 1 shows the concept of creativity according to creativity categories.

From Table 1, we conclude that an appropriate learning model for promoting creativity should be based on the ecology of creativity where four categories interact as in a flipped learning model involving a creativity-friendly environment, creative problem-based and collaborative learning that are based on processes of creativity.

For humans, creativity is needed in every conceivable task. It is at the root of every idea or concept and applies to new ways of solving problems. Most investigations of creativity have taken one of two directions (Kaufman & Beghetto, 2009). The first, eminent creativity (called "Big-C creativity") is a breakthrough but rare type of thinking that may come from a creative genius. The other relates to personal creativity (called "Little-c creativity") that an average person may use daily to enhance and enrich lives (creating new recipes, new fusions of two cuisines or coming up with new ways to increase production efficiency) (Richards, 1990). Beghetto and Kaufman (2007) found limitations in this approach, noting the interpersonal and developmental nature of creativity. Their model consists of four Cs adding Mini-c and Pro-c to represent the developmental steps of creativity. Mini-c is the personally novel and meaningful interpretation of experiences, actions and events constructing personal knowledge and understanding in a particular sociocultural context. Pro-c, attained by the developmental and effortful progression beyond Little-c, represents the professional-level expertise in any creative area. They discussed several transition paths (Beghetto & Kaufman, 2007; Kaufman & Beghetto, 2009) where everyone begins in Mini-c and can reach Pro-c through the formal apprenticeship in academic institutions or reach Little-c

**Table 1.** The concept of creativity by creativity categories.

| Category | Concept |
|---|---|
| Person | What personal characteristic is apt to produce creativity? |
| | It covers personality, intellect, temperament, traits, self-concept etc. |
| Process | How do people develop new ideas and produce creative products? |
| | It applies to motivation, perception, learning, thinking, and communicating. |
| Product | Looking at the outputs of creativity |
| | What is created when a creative idea becomes embodied in tangible form? |
| Press | Environment, and how this can influence creativity |
| | The relationship between human beings and their environment |
| Ecology of creativity | The perspective of overall interaction of previous four categories for manifesting creativity |

through tinkering – cultivating creativity in a domain through creative experiments even without well-structured mentorship. Someone, who has reached Little-c, may often reach Pro-c through an informal apprenticeship like working with an older, more experienced colleague or mentor.

### Creative Process

The creative process relates to the sequence of thoughts and actions that catalyze novel adaptive products (Todd, 2001). Understanding the creative process is very useful for establishing a learning model for creativity education. Wallas suggested the four-stage model to describe the creative process model; preparation, incubation, illumination and verification (Wallas, 1926). Guilford, however, was not satisfied with this process model which did not mention mental operations that actually occur, in terms of comprehensive understanding of creative process. He continued to identify certain abilities that might be involved in creativity; an ability to analyze problems, a capacity to produce many ideas, an ability to handle complexity and an ability to evaluate the idea (Todd, 2001).

Specifying the sub-processes in the creative process has been progressed during the past half-century. The preparation stage involves preliminary analyzing the problem, defining and setting up the problem, and preparing our brain for a trip to create something new. To investigate a problem accurately and to prepare our brain for creation, it will have to draw on education, analytical skills, and problem-solving using relevant knowledge. During the incubation stage, all conscious activities, relating to the creation that we had initially set our mind to do, are stopped and unconscious mental explorations on the problem continue. The unconscious mind discerns between useless ideas and promising ideas and rejects the vast majority of useless ideas. The illumination stage happens when the promising idea moves on to conscious awareness like the ah-ha moment. The illumination can be compared to a flash, a sudden enlightenment and is often proceeded by an intimation that an idea is happening (Todd, 2001). After deriving an idea, the individuals consciously verify whether the idea is worth pursuing in the verification stage. The verification stage involves evaluating, refining, and developing one's idea. Wallas noted that a person can go back to the early stages of the creative process in the creative problem solving (Wallas, 1926). When an idea is proven to be defective during the verification stage, one may deliberate on how to resolve this flaw.

Todd (2001) noted that variations of a creative process depend on the domain or the characteristics of the individual and should be considered in both theoretical and empirical work. The stages involved in creativity and the methods that enable these to be used together, may vary with the nature of the problem-solving task and need to be taken into account. In order words, when the individuals master specific skills in the creative process but do not know how to combine them when working on a task, creativity education may not be effective.

### Creative Problem Solving

Edward & Monika (1994) defined Creative Problem Solving (CPS) as a framework that encourages whole-brain, iterative-thinking as the most effective process; problem definition, idea generation, idea synthesis, idea evaluation, and solution implementation.

Figure 1 illustrates the cyclic, iterative nature of the creative problem-solving process and associated mindsets. Since each mindset has its own value and is suited for particular tasks and involvement in problem solving processes, the whole-brain teams or individuals, practicing whole-brain modes of information processing, are indispensable for solving a problem creatively.

Edward & Monica (1994) argued that activities related to imaginative thinking and interpersonal thinking must be part of the engineering curriculum so individuals can develop their potential in all four quadrants of the brain. CPS can be used to strengthen the productivity, the quality of teamwork, and the thinking and communication skills of students and instructors in all quadrants. It can be also used to deal with everyday problems as well as long-term challenges and opportunities (Treffinger, 2003). The CPS framework involves the four main components; understanding the challenge, generating ideas, preparing for action, and planning your approach.

### Creativity Education

Creativity education consists of three categories: "teaching about creativity", "teaching for creativity" and "teaching creatively". "Teaching about creativity" is about the concept and characteristics of creativity. "Teaching for creativity" involves a teaching plan that enables students to cultivate and demonstrate potential cre-

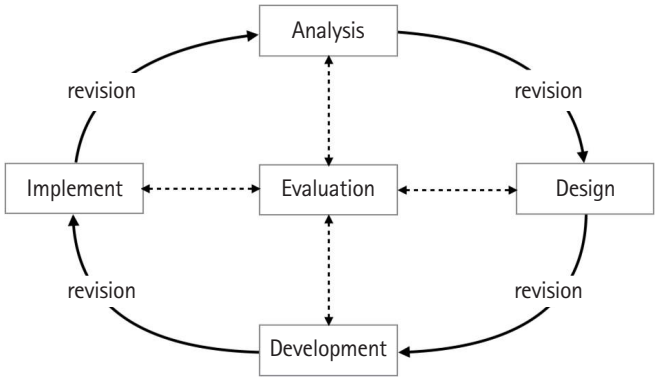


**Figure 1.** The creativity problem-solving process model.

ativity and to derive creative outcomes. "Teaching creatively" means delivering learning processes in a creative way. Figure 2 shows the educational activities and entities in terms of three categories of creativity education.

These three categories, not mutually exclusive, cultivate innovative teaching/learning strategies and improvement in the learning model involving problem-solving and self-directed learning should be considered; acquisition of new knowledge and talent will emerge for utilization in particular situations involving either individual and/or group tasks. Learning activities should be student-centered rather than instructor-centered; Table 2 shows the instructor's roles in creativity education.

### Software coding education and Problem Solving

Software coding-centric curricula, based on the concepts and principles of program languages and algorithms, aims to improve problem-solving skills consisting of logical and procedural thinking abilities. Software coding is the enabler that allows students to learn new ways of communication and expression but this is a complex skill to master (Jenkins, 2002). Applying conventional learning and teaching models to software coding does not work; there is a need to customize learning processes to allow different students to learn in different ways and at their own pace. The formative assessment with appropriate feedback rather than reliance on the summative assessment lessens the learning pressure on students.

Increasing problem solving and analytical skills enables students to grow intellectually and to think creatively (Tori, 2017), improving capacity for logical thinking and reasoning. It is the iterative experience of software coding, that increases algorithmic thinking, problem solving, and logical thinking; it can provide various opportunities for developing students' computational thinking ability. Verification items measuring effectiveness of software coding education according to three categories are depicted in Table 3.

Students who resolve their own errors when developing software programs learn also how to solve the problems of daily life because the focus is on cultivating students' cognitive, logical thinking and reflective skills. This provides a sense of accomplishment and confidence that is transferable to other courses.

### Problem-based Learning Model

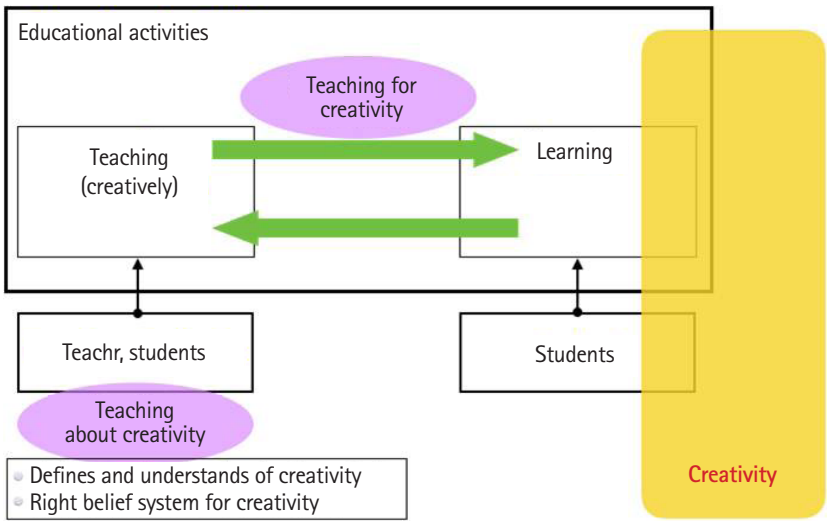


**Figure 2.** The educational activites and entities in terms of three views of creativity education.

**Table 2.** The instructor's roles and impact on improving creativity.

| The instructor's role | Impact on creativity |
|---|---|
| Accepting various opinions of students | Encouraging student's diverse creative thinking |
| Observing and empathy of individual students | Encouraging student's confidence |
| Finding problems to stimulate students | Self-thinking and problem-solving abilities |
| Passionate learning on a given topic | Presenting a role model to students and stimulating creative thinking |
| Providing an environment to recognize weaknesses of peer ideas and to ask how to overcome them | Stimulating colleagues to improve their ideas |
| Ability to lead presentations and thinking | Improving student's self-confidence |
| Ability to induce curiosity and challenge | Motivating student's creative thinking |

A learning model includes a conceptual framework that describes methods for organizing learning experiences to achieve specific mental and physical learning outcomes; this serves as a guide for instructors in creating learning activities (Sugiyanto, 2007). The intent is to make student's learning outcomes as effective as possible because they can make sense of ill-structured situations that they regularly confront in their workplace now and in the future. An important role is that of problem solver, an important aspect of professional practices (Lohman, 2000).

**Table 3.** The verification items to measure software coding education effectiveness.

| Category | Verification items of Coding education effectiveness (impact order) |
|---|---|
| Creative problem-solving ability | Problem-solving ability (3) |
| | Logical thinking ability (1) |
| | Divergent thinking ability (2) |
| | Self-assurance and independence (4) |
| Computer Science ability | Programming ability (2) |
| | Understanding of computer science and technology (4) |
| | Algorithm development ability (1) |
| | Reasoning ability (3) |
| Learning elements | Academic achievement (1) |
| | Self-directed learning ability (2) |
| | Inducing motivation or curiosity (3) |
| | Concentration (5) |
| | Potential development capability (4) |

A model that advocates real-world problems for students' development and application of logical thinking skills is PBL (Problem-based Learning). Students organize prior knowledge and seek new information for solving problems with critical thinking, and build their suite of new concepts knowledge. This model requires students to apply lessons learned from several disciplines and to adapt the concepts to new situations in a very practical way (Strobel & Barmeveld, 2009). According to Strobel (2009), a PBL model is significantly more effective than traditional instruction model in terms of producing competent students and promoting long-term retention of ways of building knowledge and skills acquired during ongoing learning experiences.

In addition, by placing students in the active role of problem solvers confronted with real-world problems in this type of instruction, students work with and alongside each other in their classrooms and communities. The main idea behind PBL is presentation of problems, queries or puzzles, that engage students' curiosity, introduce or motivate learning, and enable students to pose solutions; the starting point for PBL process is shown in Figure 3.

Similar to creativity processes, PBL, in general, consists of three phases; problem analysis phase, self-directed learning phase, and a subsequent reporting phase (Yew & Goh, 2016). Yew and Goh investigated the effectiveness of the PBL process. Previous studies showed collaborative verbal interactions around learning in the classroom can give rise to their subsequent learning achievements.

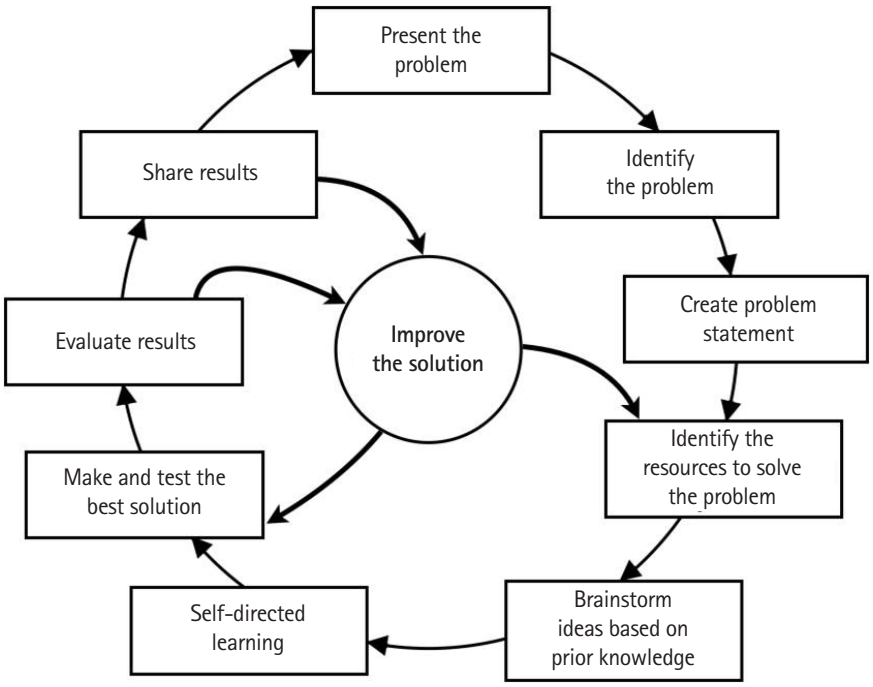


**Figure 3.** The problem-based learning process model.

Expert facilitators guide students' discussion and assist in the process of developing their collective knowledge, with open-ended metacognitive questions.

The learning issues generated by students and the availability of learning resources identified in the problem analysis phase determine self-directed learning activities to some extent. Another study found that students, who study beyond the learning issues during self-directed learning phase, can achieve better academic achievements (Dolmans, 1994; Van den Hurk, 2002; Yew & Goh, 2016). Ultimately, process variables such as the extent of the problem relevance, tutor expertise, student's prior knowledge, the extent of identification of personal learning needs, group activity, and time spent on self-directed learning all influence academic achievement. In particular, the quality of learning issues generated in the problem analysis phase, influences group activity that in turn affects the time spent on self-directed learning. The more time spent on self-directed learning, the greater the potential for acquisition of new knowledge. In terms of learning activities, previous studies mainly considered self-directed learning and collaborative learning that are essential in the learning process. However, formal investigation to ascertain the extent to which activities or phases of PBL process impact students' learning achievement has not been done (Yew & Goh, 2016).

### Concepts and Features of Flipped Learning

Flipped learning is a pedagogical approach in which the conventional notion of classroom-based learning is reversed; instructors provide online learning materials or related materials to students before class to prepare in-class time dedicated to deepen understanding through interactive exercises, projects, or discussion with peers based on the learning materials and problem-solving activities facilitated by instructors (Flipped learning, 2019). The concept stemmed from a model of 'peer instruction' developed by Eric Mazur. He encouraged student engagement in deeper cognitive thinking via peer instruction and instructor's challenges in the classroom. This model was expanded to include technological elements such as web course management tools by Baker (2000) who developed the 'flip' concept and enunciated the role of instructors as facilitator, adviser, coach or 'guide on the side'. Subsequently, flipped learning provided an inclusive learning environment in which personalized coaching and mentoring were the norm (Flipped learning, 2019). The learning processes intentionally cause a shift to a student-centered model in which students explore given topics in greater depth and get meaningful learning opportunities. Another intent is to move students away from passive learning to active learning involving collaborative activity and peer learning within PBL. In this context, instructors are no longer knowledge transferors but rather facilitators of students' more self-directed learning. After in-class activity, students reflect on the feedback they receive and use the feedback to further their learning.

Flipped learning has some pros and cons. The main advantage is that students can learn at their own pace, cultivate personalized learning experiences, the ability for student-centered learning and collaborative learning and this model encourages student's engagement. However, it requires student active participation and collaboration and all students may not complete the pre-class session. It may be more effective for students who have meta cognitive skills that are about knowing ourselves such that how to learn and what learning style suit us very well. self-discipline is indispensable for the flipped learning. Thus, flipped learning is suitable for university students.

Despite disadvantages of the flipped learning model, flipped learning seems to be a very effective, hands-on approach for diving deeper into the learning material, improving student outcomes, helping where needed but enabling greater student involvement in their own learning processes. "Flipping the class" is an iterative process, so as instructors implement these practices, they can reflect on what works well or what needs to be enhanced (Flipped Classroom, 2019).

## DEVELOPMENT OF SOFTWARE CODING LEARNING MODEL

Within a computer programming course about C++ language in the fall semester of 2018, 31 students were enrolled. Using flipped learning, students can acquire basic knowledge, concepts, or simple program codes that help some conceptual understanding before the class and then they have enough time during in-class time to profoundly expand on pre-class learning as a result of particular activities. We adopted collaborative learning and CPBL in the classroom for basic problem-solving and then application to complex problems in order to cultivate individual creativity through self-direction in problem finding and resolution. It seems that collaborating with and learning from other students may be just what is needed to give the likelihood of creative outcomes a boost.

Collaborative learning, in this study, aims at learning how to program a code practically and creatively through discussion with others but reaching their own solution, deriving an algorithm, and programming a code with other students. Instructors selected and presented problems that students should solve individually or in collaboration with their colleagues. Each group consisted of four or five students. Instructors had all students of each group summarize results of discussion including pseudo codes or flow-charts expressing algorithms. Students wrote an individual report on the re-

quired function descriptions and program codes. Following report submission, students evaluated the reports of up to five other students. With this peer assessment, students investigated the procedures other students proposed and looked for different or better approaches than their own. Then, instructors evaluated students' program codes for resolution of presented problem and gave quizzes to check whether each student understood basic concepts. Finally, instructor had students present their own result. In Figure 4, we depict overall educational practice activities in our proposed flipped learning model involving elements of PBL.

Educational processes may be influenced by individual differences such as aptitude, passion, or curiosity about something new. Some students may experience difficulties in understanding basic concepts, while others can easily or creatively apply what they learned to solve new problems. In this study, learners, who were assigned to small groups, began interacting with an instructor or peers to build up knowledge based on relevant materials. They also learned where to go to seek out more to solve a large real-world problem, using the CPBL model.

To encourage creativity, we provided adequate problems to act as a driving force for developing meta cognitive skills; students considered carefully how to learn more effectively by monitoring self-directed learning and managing it. Student activities included the following:

i) identifying a problem, describing a problem, and defining a learning plan–current understanding and analysis of overall goal (s)
ii) decomposing a problem into sub-problems that are manageable
iii) identifying resources to solve the problem including what students have already learned
iv) brainstorming ideas to find a conclusion for a specific problem
v) making and testing the best solution, and evaluating results
vi) articulation of problems and solutions
vii) reflecting on how students learned more effectively, and self-assessment of what students achieved
viii) self-assessment of learning by developing strategies for testing new programming knowledge and making use of supplied self-assessment tools
ix) practicing active listening and other communication skills to share their own solutions, to clarify elements of solutions, and improve solutions.

The activities of collaborative learning and CPBL models in the context of flipped learning are shown in Figure 4. Collaborative

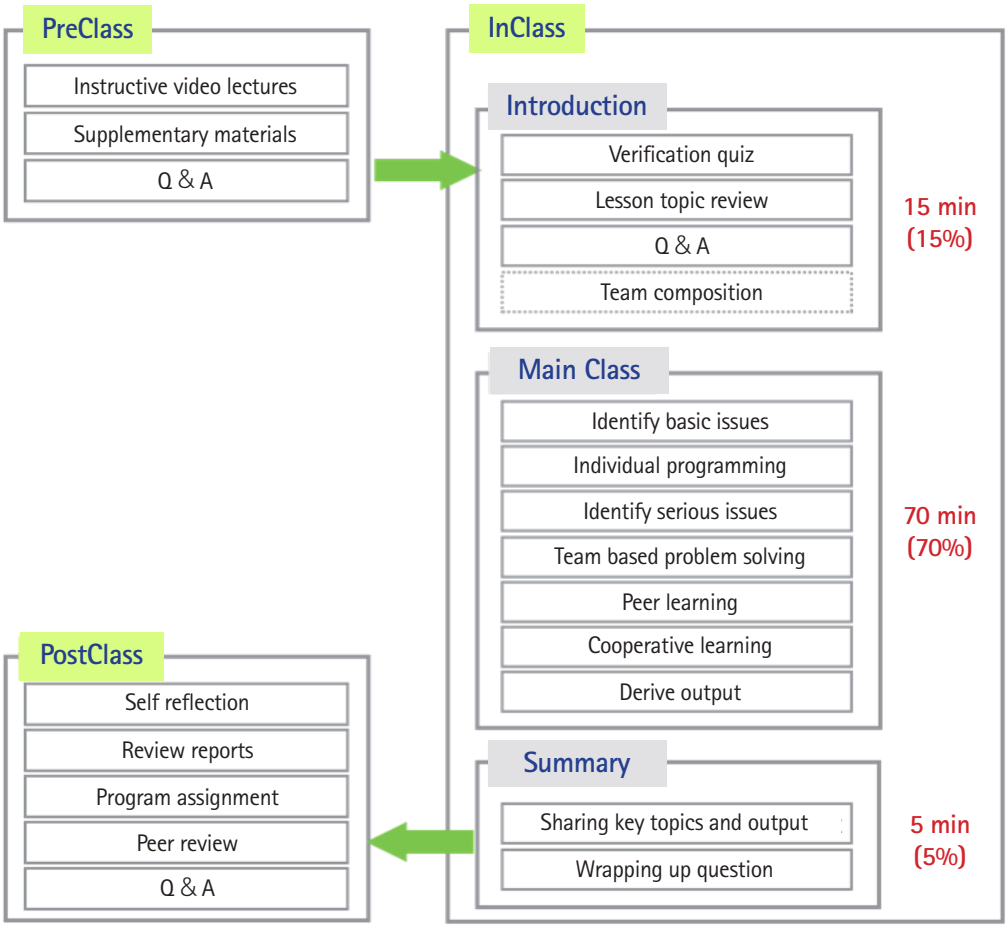


**Figure 4.** The educational practice activities adopt flipped-learning model including creative problem-based learning activities and collaborative learning activities.

learning includes peer-review on the individual report.

**Findings**

Given our belief that students' perceptions and attitudes towards the learning model may have a noticeable effect on learning, we used an open-ended questionnaire using a typical five-level Likert items from "strongly disagree" to "strongly agree". We sought students' perceptions of experiences with collaborative learning model and CPBL models and the general impact of flipped learning.

An open-ended section of the questionnaire included some items which gave students the opportunity to provide further information, on their negative or positive perceptions of the learning approaches", "Can flipped learning be applied in other classes?", "Do you have any other comments, criticisms or suggestions?" Table 4 provides an overview of responses.

To investigate the effectiveness of the proposed learning model, additional questions were posed. The questions and responses are depicted in Figures 5 and 6. From the survey, we conclude that collaborative learning and additional self-directed practices in classroom can help students more deeply appreciate the concepts of programming language. However, most students still think software coding too difficult to declare self-confidence on creative programming a code over one semester.

## CONCLUSION

In this study, we proposed a learning model for software coding education combining flipped learning and collaborative learning models with CPBL and investigated its perceived effectiveness on the cultivation of creativity through activities in software coding education for students majoring in game engineering. Since modern generation students are accustomed to learning new knowledge using applications with the information communication technology (ICT), instructors, in modern classrooms, are no longer the only major source of knowledge, but have become facilitators of student learning.

The proposed learning model was designed to provide customized learning content so that students could engage in self-directed

**Table 4.** The students' positive and negative comments on proposed learning model.

| | Students' responses |
|---|---|
| positive comments | "I can review what I learned from the assignment each week and found out what I did not understand in this course." |
| | "It was hard because there were many problems to be solved, but it was helpful to understand program language." |
| | "It was great to have a lot of time to coding programs based on various problems. |
| | "Informative, easy to learn and understand" |
| | "Peer review was a great way to get to know peers' program codes and solutions. |
| negative comments | "It was hard to catch up the class without pre-class activities for preparation on in-class activities." |
| | "It would be easy to understand if you gave a lot of examples in real life." |
| | "Sometimes, I did not have the time to watch all lecture videos and study the issues at home, because I did other homework all day." |
| | "I could not get any benefits of peer review. |

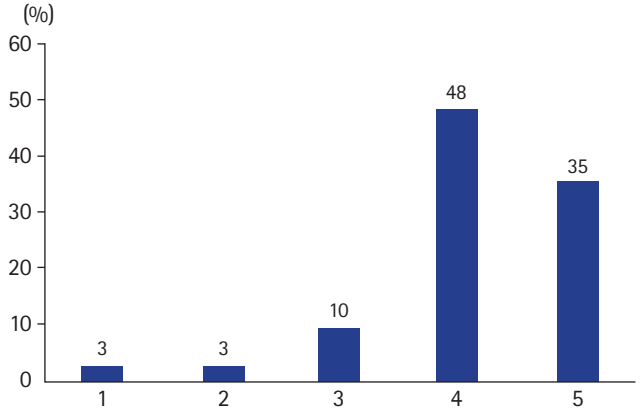


**Figure 5.** Response of "Collaborative learning in a group helped you understand the concepts of program in depth." (Responses: 31, average: 4.09)

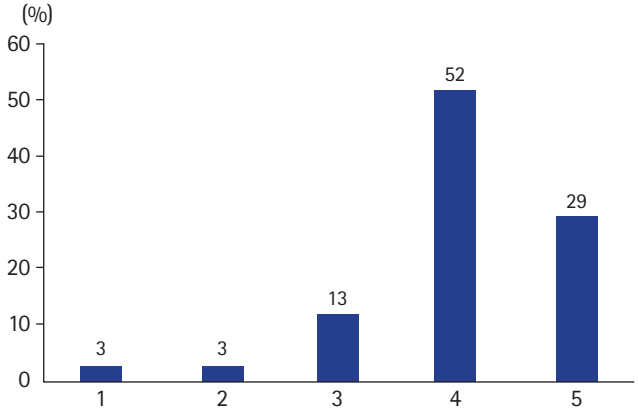


**Figure 6.** Response of "Additional self-directed practices helped you understand the concepts of program in depth." (Responses: 31, average: 4.0)

learning at their own pace; each student received the appropriate feedback after formative evaluations of problem-solving ability and creativity in response to various problems.

Our survey in this study showed feedback on student perceptions of self-directed practices, potential to improve creativity and understanding of basic concepts and principles of programming languages. The timeline was too short for us to investigate the effectiveness of the proposed learning model in detail.

In future work, we intend to continue this study in order to collect more data about the proposed learning model and its effectiveness; an objective evaluation method should be developed if we are to verify the effectiveness of the proposed learning model. Various creative problems with different difficulty levels should be provided to students to cultivate the likelihood of students' self-confidence.

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# Project Based Learning to Enhance Environmental Education through Automobile Mechanics

Noelio Vázquez Vargas[1], José Luis Aveleira Ortiz[1], Nancy Pérez Pueyo[1], Angel Roberto Leyva Rodríguez[2]

[1]Master of Education and Associate Professor, Las Tunas University, Las Tunas, Cuba
[2]Manifiesto de Montecristy Technical and Vocational School, Las Tunas University, Las Tunas, Cuba

**Purpose:** The purpose of the chosen project was to apply the principles of Problem-based Learning (PBL) to plans for curriculum renewal reliant on project-based learning events within the Cuban Vocational Training sector.
**Methods:** Examinations of the baseline and diagnostic assessments, lesson observations and the teaching experience of the authors revealed different perceived limitations in the initial education of Cuban skilled workers and technicians. There was a need to develop a novel approach to projects undertaken by students.
**Results:** Six implementation phases involved students identifying problems; analyzing human and other resources needed; proposing actions involving theoretical and practical action plans; execution of plans; presentation of results. Project evaluation was proposed: A variety of assessment methods were used such as self-assessment, peer assessment and group assessment where not only the results are assessed but also the whole process and development of skills, values and attitudes.
**Conclusion:** This curriculum renewal process reliant on PBL philosophy showcased an example of Work-integrated learning and provided insight on what can be done in terms of contributing to sustainable development at a school and community level. It involved engagement of teachers with some key elements of PBL pedagogy as an example of Automobile Mechanics Project based on the Cuban educational context. This approach ensured students acquired not only subject content knowledge but also skills and attitudes to meet complex demands in their chosen field.

**Keywords:** Sustainable development; Pollution; Project based learning; Automobile mechanics

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Corresponding author:
Noelio Vázquez
Avenida Carlos J. Finlay s/n, Reparto Buenavista Las Tunas 75200, Cuba
Tel: +53-3134-7339
Fax: +53-3134-7339
E-mail: noelio@ult.edu.cu



## INTRODUCTION

Developments within younger generations requires Technical and Vocational Education and Training (TVET) institutions create a competent, adaptable and innovative workforce, contributing to sustainable development. This is justified by the fact that those institutions prepare individuals for their initial entry into employment and provide upgrade training for the employed individuals. Learning in the 21st Century should ensure learners not only have knowledge and skills but the ability to meet complex demands by drawing on and mobilizing resources to solve professional problems in particular contexts. These issues led the authors to pose the following question:

How are learning activities taking place in the TVET institutions?

The results of the baseline and diagnostic assessments, as well as lesson observations within an evaluation project revealed different perceived limitations in the initial education of Cuban

skilled workers and technicians. The project was implemented as part of the teacher training and development program offered by Las Tunas University in partnership with Las Tunas Department of Basic Education to different TVET institutions. These limitations are:

- Teachers frequently present fragmented subject content that is decontextualized from real life situations.
- Teachers persistent use of traditional problems; this is not enough to promote the development of skills to approach novel situations and deal with real life problems.
- Occasionally, problems are solved and the field of application is not taken into consideration.
- During lessons, teachers do not draw attention to real life application of concepts. These limitations in approach of teachers negatively impact on students because:
- Students solve problems mechanically or without a deep understanding of theories.
- Students are unable to solve real life problems.

This situation shows contradictions between the demand for preparing a technically competent and skilled Cuban workforce and the preparation of TVET teachers.

Given the above, the following problem was identified: What would lead to improvements in the educational preparation of Vehicle Service Technicians who need to solve the diversity of professional problems they face in workshops?

Considering that most of Cuban vehicle and transport infrastructures are underdeveloped and have been used for more than 20 years this has had a significant impact on the environment (Cuesta Santos, et al., 2019). Vehicle Service Technicians were therefore taken as a priority to develop environmentally sound education projects.

## PROJECT BASED LEARNING

This article looks at the problem outlined above through the lens of project-based learning (PBL) pedagogy. PBL engages students with learning and school through active exploration of real world problems and challenges. Students explore, make judgments, interpret, and synthesize information in meaningful ways (Harun, 2006). The authors provide an overview of how TVET teachers embraced some key issues regarding PBL pedagogy and an example of their efforts with PBL implementation based on the Cuban educational context.

To begin a literature review showed that the roots of PBL were in the progressive educational movement which promoted more student involvement and engagement (Peterson, 2012). It was recognized that William Heard Kilpatrick developed the ¨Project Method¨ inspired by the philosophy of John Dewey (Chipman & McDonald, 1980). Evidence also highlighted the concept of learning through projects that was developed in the 17th and 18th centuries (Knoll, 1997).

We then asked How is PBL defined? Research on this topic showed that PBL is defined in different ways. Some authors considered it as a pedagogy, while other authors considered it as a pedagogical approach, an active style of learning, a type of inquiry-based learning, or a method.

For example, Bell defined PBL as "a student-driven, teacher-facilitated approach to learning because students pursue knowledge by asking questions that have attracted their natural curiosity" (Bell, 2010). On the other hand, "PBL is considered to be a particular type of inquiry-based learning where the context of learning is provided through authentic questions and problems within real-world practices" (Al-Balushi & Al-Aamri, 2014).

As stated by these two definitions, PBL is student-centered and it places students in the active role of problem solvers but it is seen as a learning approach based on the concept of inquiry-based learning.

For our context and project oriented purpose, the definition of PBL as a method was assumed.

"PBL is a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge" (Buck Institute of Education, 2018).

As stated by (Knoll, 1997) "The project is one of the standard teaching methods. It is generally considered a means by which students can (a) develop independence and responsibility, and (b) practice social and democratic modes of behavior".

Knoll definition reinforces the idea of PBL as a student-centered teaching method but it introduces other elements such as the development of attitudes and values.

PBL is student driven, (Bell, 2010) and that is why it usually begins with a driving question or real life problem which leads to the creation of an artifact (model, design, device, computer program, arts, etc.) by mean of completion a variety of tasks. The socialization aspects of the project are critical but enquiry processes involve written and oral ways of summarizing the procedure used to produce the product and present the outcomes. The following benefits of PBL were part of what we hoped to achieve:

- Provision of an integrated approach to understanding concepts and knowledge.
- Development of practice and research (evidence-based) skills.
- Facilitation of collaborative learning and team work.
- Facilitation of interdisciplinary work (connections across different subjects).

- Provision of stronger and more relevant preparation for practice.
- Improvement in learner engagement in school.
- Strengthening of learner motivation and interest.
- Making learning experiences more relevant and meaningful.
- Allowing teachers to assign projects for students with a diverse variety of interests, motivations, intelligences, learning styles, abilities, career aspiration and personal backgrounds.

Thus we posed another question: What must a project have in order to be considered PBL?

These are some design principles of PBL (Thomas, 2000).

- Centrality of core curriculum elements consistent with PBL methodology.
- Driving Questions: PBL methods are focused on real life questions and problems which catch student attention and "drive" students to propose solutions considering the central concepts of PBL and the principles underpinning a discipline.
- Constructive Investigations: PBL involves students in a constructive investigation, in this way, students are familiarized with the scientific method and current scientist activities.
- Autonomy: PBL methods are student driven and the teacher plays the role of facilitator or mentor.
- Realism: PBL events are not simple learning activities to be covered during a lesson. The approach enables students to look at real world challenges.

To implement PBL as a project different phases need to be considered (Tellez Lazo, 2005):

First phase: Identification of the problem or driving question. The problem can never be imposed by the teacher. The students are free to choose the problem to be investigated but it must be in accordance with the core curriculum elements and the needs of the school and the company in which it will be implemented.

Second phase: Analysis of necessary human and materials resources. It is important to analyze the availability of material resources to complete the project as well as the class in terms of diversity (Intelligence, learning styles and economic, educational and cultural backgrounds).

Third Phase: Design of action plan - These actions are planned from theoretical and practical points of view. PBL is student driven and that is why the teacher serves as a facilitator guiding this phase. Students would be more committed with the project if they have an active role in deciding activities (Harun, 2006).

Fourth Phase: Execution of designed actions. This is the longest phase. Here, individual and group work take places. The students socialize to achieve the results in collaborative ways. As the objectives of the project are achieved, professional and research skills are developed.

Fifth Phase: Presentation of results. Students write about and present the results. This is important to develop language skills.

Sixth Phase: Project evaluation. A variety of assessment methods are used such as self-assessment, peer assessment and group assessment. Not only the results are assessed but also the whole process and development of skills, values and attitudes.

These phases can be summarized in the Project Based Cycle (see Figure 1).

## AUTOMOBILE MECHANICS EXAMPLE

**Project overview**

Pollution is a serious problem. Scientists are now worried about its influences in changing the Earth's atmosphere because of carbon dioxide emissions from cars and industry. If we do not do something quickly, the Earth's ecosystem, including its weather, might be quite different in the next centuries. Every year the burning of fossil fuels and tropical forests releases over ten billion tons of carbon into the atmosphere (UN, 2018).

One needs to ask: Is life experience really better than it was a hundred years ago? It is certainly true that people live longer than they used to, travel faster than they could and own more things than they did. Humans have made great progress in industry, science, technology and medicine but we still have to tolerate noise and bad air which are critical challenges of modern life. Industry and modern life do not have to be enemies of beauty. Progress does not need to be aggressive. It does not have to destroy nature. We can have both beauty and progress if we really want this. We need clean rivers and open countryside just as much as a hundred years

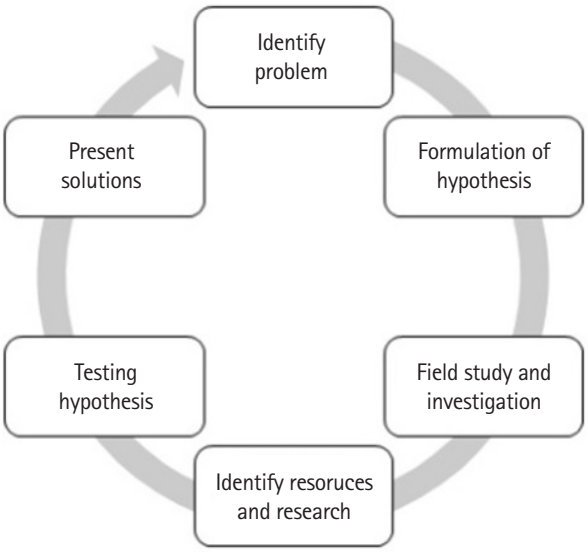


**Figure 1.** Project Based Learning Cycle

ago. Perhaps, in some ways, we need them even more. Things like open land, clean water and good air are becoming unusual and infrequent all over the world. These environmental changes have brought the international community to adopt global, regional, national and local measures to prevent and control its impacts (Statistics and Information National Office, 2015).

For these reasons, the following project was proposed; it takes place at the service workshop of the Municipal Transportation Company in Jobabo Municipality, Las Tunas province, in the Republic of Cuba. This Government Company is responsible for the urban and rural public transportation within the municipality and its workshop serves as a classroom to carry out the practical lessons of "Manifiesto de Montecristi" Technical and Vocational School and the place where learners develop their volunteer community service.

The staff of this workshop did not accomplish the Environmental Security Standards concerning oils, greases and residual fuels disposal during maintenance and reparation of the motor vehicles and they do not have the grease traps that are established protocols. Lubricants and fuels were spilled and spread out all over the ground and mixed with water, polluting the soil, underground and runoff waters. Any grease that enters to grease trap or interceptor is called 'brown grease'. This grease needs to be disposed of appropriately. This recovered grease is often suitable for recycling in to bio-diesel and thus it can have some value.

### Driving Question/Problem

The key question was "How do practitioners improve achievement of the Environmental Security Standards, implement sustainable measures concerning oils, greases and residual fuels disposal during maintenances and reparations of motor vehicles?"

The project outlined provided students interested in sustainable development with the foundational concepts for engagement with the future sequence of courses such as those available to automobile mechanics, mechanics, other practitioners eg those involved with pollution, conservation, recycling, maintenance of safety and security rules.

### Hypothesis

The following hypothesis was proposed:

If sustainable measures concerning oils, greases and residual fuels disposal during maintenance and reparation of motor vehicles are used, the Environmental Security Standards in the workshop area and the community would be improved.

### General objective

Upon completion of this project, students should be able to use critical thinking processes to develop a system for maintenance and reparation of motor vehicles that incorporates basic ecological principles and sustainable management practices which contribute to the development of values such as love for nature, friendship and responsibility; under supervision of senior teachers and technicians.

### Specific objectives

To develop enquiry and processing skills that will enable students to assume roles that enable them to:

- Identify the key principles of sustainable development.
- Describe several different models of sustainable development.
- Apply the principles of sustainable development and environmental friendly measures during reparation and maintenance of motor vehicles to keep them in good running conditions.
- Observe the global, regional, national and local environmental regulations.
- Examine vehicles to ascertain the nature and location of defects either by running engine or driving vehicles on road to prevent environmental damages during its operation.
- Dismantle partially or completely defective unit or parts of vehicle such as engine, gear box, rear axle, front axle, steering assembly, radiator, etc. according to nature of repairs to be done, using hoist, jack, pullers, hand tools and other devices applying safety and environmental friendly measures.
- Lubricate joints, tighten loose parts, test performance of vehicle by driving on road and make necessary adjustments to attain desired safety and national environmental standards.
- Execute techniques concerning oils, greases and residual fuels disposal during maintenances and reparation of motor vehicles.
- Explain how to avoid soil and water pollution arising from use of fuels and lubricants.
- Investigate the different chemical components of fuels and lubricants that pollute the water.
- Develop an environmental awareness.
- Examine, quantitatively and qualitatively, the amount of fuels and lubricants spilled during maintenances.
- Calculate the economic losses due to the spilling of the lubricants during maintenance.
- Socialize in projects in a way that results in collaboration with other community members and workers.

### Group project requirements

To organize the group work in a manner consistent with PBL, we proposed the following requirements:

- Groups of no more than five will be formed to complete the group portion of the project and ensure effective involvement.

- Each member of the group will be given an area of responsibility.
- In case of a group with less than four members, each member may have more than one responsibility.
- In PBL it is important to place the student in the actual roles of the practitioners in the workplace. The roles were as follows:

**Project leader:** This member gets information to absent students, meets deadlines, fills absent members in, coordinates the efforts of the entire group, ensures that group members understand the functions/tasks, ensures that group members perform all assigned duties efficiently, supports other group members and readily provides additional assistance if needed.
**Engineer:** Main design ideas would come from this person; she/he works with the leader in assigning the various functions/ tasks to group members. She/he adopts safety measures, personally, for the tools, job and environment.
Vehicle service technician: Provides maintenance and repair for motor vehicles observing the Environmental Security Standards established.
**Manager:** This member develops the budget, ensures group stays on budget, keeps financial records, builds components as assigned.
**Speaker/Communicator:** This is the person who writes the report and presents the results of the project to other students and professionals in different scenarios, local and national events organized by the Department of Basic Education.

**Topics and concepts**

This project facilitates interdisciplinary work. Concepts from different subjects were integrated in situations/scenarios that were part of learning activities. For example:
Mechanics of Motor Vehicles: Internal combustion engine; Petrol Engine Basics; Gasoline Engine Basics; Exhaust emission test of petrol and diesel engine; Acoustic emission testing; Leak testing: Bubble emission testing, Air leak testing.
Environmental Factors: Soil pollution and conservation; Water pollution and conservation; Air pollution and conservation; Noise pollution.
Chemical Factors: Hydrocarbons; Fuels and combustion; Chemical components of fuels and lubricants; Exhaust emission gasses.
Mathematical Factors: Calculation of areas and volumes; Statistics.
Physical Factors: Measurements and Measuring instruments; Work, energy and power; Hydrodynamic; Thermodynamics; Combustion engines.
Biological Factors: Ecosystems; Conservation.
Economic Factors: Cost; Economic losses.

**Materials and Resources**

Maintenances Observation Guide; Tools; Lubricants; Automotive Vehicles; Automobile parts; Manual of Mechanics of Automotive Vehicles; Rules of Usage of Fuels and Lubricants; Real life objects; Pictures and videos; Computers and stationery.

**Time Line**

The project was completed in four months, over the Christmas term from September to December. The first and second weeks were dedicated to diagnosing the relevant issues around environmental and working conditions within the workshop. During the third and fourth weeks a literature review on sustainable development practices was made. The second and third months the learners provide maintenance and repair motor vehicles and executed environmental friendly techniques concerning oils, greases and residual fuels disposal during maintenances and reparations. The last month learners evaluated the results. The presentation of results to other students was held at the end of the fourth month but the presentation of results to other professionals in different scenarios, local and national events organized by the Department of Basic Education was held after complexion of the project according to the academic year calendar.

## RESULTS

The authors reflected on the benefits and challenges of project implementation.

**Benefits**

Upon completion of the project the following benefits can be summarized.

The project using Work-integrated learning consistent with PBL principles:

- Implemented sustainable development and environmental friendly techniques concerning oils, greases and residual fuels disposal during maintenances and reparations of motor vehicles which contributed to conserve the soil and water not only in the workshop area but the community as well.
- Promoted an environmental and production awareness at a School and Community level.
- Provided students with an integrated understanding of the concepts and knowledge on sustainable development.
- Developed practical and research skills, views and attitudes within the student group.
- Facilitated interdisciplinary work (connections across different subjects).
- Improved student motivation.

- Made learning experiences more relevant and meaningful.
- Facilitated student use of processes of Practice and Inquiry-Based Learning and PBL.

### Challenges

As every human activity, the project implementation was not perfect; some challenges arose:

- Some Vehicle Service Technicians underestimated learners' preparation and motivation and refused to share experiences with them.
- The students faced some concerns since they have to learn outside of school (field and home) with adults who are not trained educators such as Vehicle Service Technicians and Workshop Skill Workers.

### Project valuation

This involved a range of appraisals of approaches to assessment and evaluation of the implementation of the project.

### General rubric for project written reports

A rubric with seven indicators consistent with PBL to assess different levels of performance was proposed to evaluate the project written report (see Table 1).

### General rubric for oral presentations of projects

A rubric with seven indicators and different levels of student performance was proposed to evaluate oral presentations of projects (see Table 2).

**Table 1.** General Rubric for Project written reports

| Indicators | Levels of performance | | | | |
|---|---|---|---|---|---|
| | Exemplary | Proficient | Satisfactory | Below standard | Unsatisfactory |
| Information sources | Used a variety of relevant sources (three or more different types and several of each type of source). Cited all sources. | Used many sources of two types. Cited all sources. | Used many sources of one type (e.g. textbooks, Internet, journals, magazines, questionnaire. Sources were referenced. | Two or three sources were used. | One source used and referenced. |
| Sources had data to support claims. | All sources (but one) had data to support claims. | Most sources had data to support claims. | Some sources had data to support claims. | One source had data to support claims. | No source had data to support claims. |
| Extracted relevant information. | All information extracted was relevant to the topic. | All information extracted was relevant to the topic. However, no information was given for one aspect. | Some relevant and some irrelevant information was extracted. | Little relevant information was extracted. | Little information was extracted; it was mainly irrelevant. |
| Paraphrased information. | All information extracted was paraphrased and well written. | Most information was paraphrased and well written. | Some information was paraphrased. However, copied portions were not indicated. | Most information was copied from sources. | All information was copied from sources. |
| Organized information. | Information was very clearly and sequentially organized. The position was logically stated with supporting data. Alternative points of view were included. | Information is clearly and sequentially organized. Logically stated position with supporting data. | Information was clearly and sequentially organized. | Information was sequentially organized. | Information was written haphazardly. |
| Synthesized | Project clearly and articulately showed: problem, hypothesis, method of research, literature reviewed, findings, analysis of findings, position. | Project showed: problem, hypothesis, method of research, literature reviewed, findings, analysis of findings, position. | Project showed problem, hypothesis, method of research, literature reviewed, findings, analysis of findings, position (one missing). | Project showed problem, hypothesis, method of research, findings. | Notes shown on aspects of the project. |
| Language | Write clearly and distinctly throughout the report, does not have writing errors. | Write clearly and distinctly throughout the report, have no more than two writing errors. | Write clearly and distinctly for most of the report, makes no more than two grammatical and writing errors. | Misuse key vocabulary, have more than two grammatical and writing errors. | Misuse key vocabulary, have more than ten grammatical and writing errors. |
| Grade | A 86 – 100 | B 71 – 85 | C 56 – 70 | D 41 – 55 | F 40 and lower |

**Table 2.** General Rubric for oral presentations of projects

| Indicators | Levels of performance | | | | |
|---|---|---|---|---|---|
| | Exemplary | Proficient | Satisfactory | Below standard | Unsatisfactory |
| Preparedness | Completely prepared. | Seemed well prepared but could have spent more time rehearsing. | Somewhat prepared, but seems not to have rehearsed. | Did not seem prepared to present. | Appeared to have made no effort to prepare. |
| Time/length | Duration was for the required time. | Duration was longer or shorter than the time allotted by 0 – 20% of duration. | Duration was longer or shorter than the time allotted by 21 – 30% of duration. | Duration was longer or shorter than the time allotted by 31 – 40% of duration. | Duration was longer or shorter than the time allotted by 41 – 67% of duration. |
| Enthusiasm | Facial expressions and body language evoked a strong interest in and enthusiasm from the audience. | Facial expressions and body language sometimes evoked a strong interest in and enthusiasm from the audience. | Facial expressions and body language were used to spark interest and enthusiasm from the audience but the expressions seemed faked. | Very little use of facial expressions and body language. Did not evoke interest or enthusiasm from the audience. | Little enthusiasm was shown by the presenter(s). |
| Content information | Included the necessary information which was correct and current. | Included the necessary information which was correct. | Information included was correct. However, it included necessary as well as some unnecessary information. | Less than 50% of the required information was included. | Insufficient information was given, some of which was incorrect. |
| Language | Speaks clearly and distinctly throughout the presentation, does not mispronounce words. | Speaks clearly and distinctly throughout the presentation, mispronounced one and two words. | Speaks clearly and distinctly for most of the presentation, mispronounces key vocabulary or makes one or two grammatical errors. | Mumbles at one or two points, more than two grammatical errors. | Mumbles most of the presentation, mispronunciation and grammatical errors. |
| Effectiveness in making a point. | Song etc. was very effective in marketing its message. | Song etc. made a point strongly. | Song etc. made a point related to the topic. | Information in the song etc. was disjointed. | Lyrics did not portray a theme. |
| Creativity | A very high level of creativity shown. | A good standard of creativity shown. | Some creativity shown. | Creativity shown. | Little or no evidence of creativity is shown. |
| Grade | A 86 – 100 | B 71 – 85 | C 56 – 70 | D 41 – 55 | F 40 and lower |

**Project evaluation questionnaire**

A questionnaire was developed for feedback from teachers (see Table 3 and 4).

## CONCLUSIONS

This project was an example of Work-integrated learning that provides insights on what can be done in terms of contributing to sustainable development at a school and community level. It involved TVET teachers in engagement with some key elements of PBL pedagogy as an example of Automobile Mechanics Project based on the Cuban educational context, in which one of the atmospheric and air pollution source is the transport infrastructure running with obsolete motor vehicles. This approach ensured students acquired not only subject content knowledge but also skills and attitudes to meet complex demands; the project was drawing on and mobilizing resources to solve professional problems in a particular context with an interdisciplinary perspective. The example provided increased students motivation, participation and engagement and at the same time it contributed to outcomes consistent with deeper and more meaningful learning than otherwise might have occurred when students are exposed to more passive experiences.

## ACKNOWLEDGEMENTS

Our deepest appreciation to all those who provided us the possibility to complete this paper. A special gratitude we give to the associate editor of the Journal of Problem-Based Learning, Dr. Meeyoung Park, whose contribution in stimulating suggestions and encouragement, helped us to improve this article, especially in writing it. Furthermore, we would also like to acknowledge with much appreciation the crucial role of the Journal of Problem-Based Learning, which gave us the opportunity to publish and socialize this experience.

**Table 3.** Question 1. Below are a series of statements. Please respond by circling the number you feel most reflects your opinion

| Items | Strongly agree | Agree | Uncertain | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| Indicator 1: Project Content and Organization | | | | | |
| 1. The project objectives were clear. | 5 | 4 | 3 | 2 | 1 |
| 2. The project workload was manageable. | 5 | 4 | 3 | 2 | 1 |
| 3. The project was well organized (e.g. timely access to materials, notification of changes, etc.) | 5 | 4 | 3 | 2 | 1 |
| Indicator 2: Student Contribution | | | | | |
| 4. Student attendance was good during the whole project. | 5 | 4 | 3 | 2 | 1 |
| 5. Students participated actively in the project. | 5 | 4 | 3 | 2 | 1 |
| 6. Students behavior was appropriate during the whole project. | 5 | 4 | 3 | 2 | 1 |
| Indicator 3: Learning Environment | | | | | |
| 7. The learning environment encouraged participation. | 5 | 4 | 3 | 2 | 1 |
| 8. The learning environment was conducive to learning. | 5 | 4 | 3 | 2 | 1 |
| 9. The learning environment was conducive to researching. | 5 | 4 | 3 | 2 | 1 |
| Indicator 4: Materials and Resources | | | | | |
| 10. The availability of materials and resources was appropriate. | 5 | 4 | 3 | 2 | 1 |
| 11. Learning materials and resources were relevant and useful. | 5 | 4 | 3 | 2 | 1 |
| 12. The provision of learning resources on the Web was adequate and appropriate. | 5 | 4 | 3 | 2 | 1 |
| Indicator 5: Assessment | | | | | |
| 13. The methods of assessment were reasonable. | 5 | 4 | 3 | 2 | 1 |
| 14. Feedback on assessment was timely. | 5 | 4 | 3 | 2 | 1 |
| 15. Feedback on assessment was helpful. | 5 | 4 | 3 | 2 | 1 |

This questionnaire is a survey evaluating projects as part of the institutional self-evaluation of "Manifiesto de Montecristi" Technical and Vocational Education School. The survey provides you an opportunity to evaluate the projects you were involved in the previous academic year. You are kindly requested to give your opinion trough filling in the questionnaire provided.

**Table 4.** Question #2: Indicate the level of achievement during the project

| Items | Excellent | Very good | Good | Fair | Poor |
|---|---|---|---|---|---|
| Indicator 6: Knowledge | | | | | |
| 16. Mathematics, Science, Humanities and professional disciplines. | 5 | 4 | 3 | 2 | 1 |
| 17. Problem formulation and solving skills. | 5 | 4 | 3 | 2 | 1 |
| 18. Collecting and analyzing appropriate data. | 5 | 4 | 3 | 2 | 1 |
| 19. Ability to link theory to practice. | 5 | 4 | 3 | 2 | 1 |
| 20. Computer knowledge. | 5 | 4 | 3 | 2 | 1 |
| Indicator 7: Communications Skills | | | | | |
| 21. Oral communication. | 5 | 4 | 3 | 2 | 1 |
| 22. Report writing. | 5 | 4 | 3 | 2 | 1 |
| 23. Presentation skills. | 5 | 4 | 3 | 2 | 1 |
| Indicator 8: Interpersonal Skills | | | | | |
| 24. Ability to work in teams. | 5 | 4 | 3 | 2 | 1 |
| 25. Leadership. | 5 | 4 | 3 | 2 | 1 |
| 26. Independent thinking. | 5 | 4 | 3 | 2 | 1 |
| 27. Motivation. | 5 | 4 | 3 | 2 | 1 |
| 28. Reliability. | 5 | 4 | 3 | 2 | 1 |
| 29. Appreciation of ethical values. | 5 | 4 | 3 | 2 | 1 |
| Indicator 9: Work skills | | | | | |
| 30. Time management skills. | 5 | 4 | 3 | 2 | 1 |
| 31. Judgment. | 5 | 4 | 3 | 2 | 1 |
| 32. Discipline | 5 | 4 | 3 | 2 | 1 |

Thank you for the time to answer all the questions.

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# Instructions for Authors

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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 . This peer-reviewed journal offers information for evidence-based practice and innovative strategies for Problem-Based Learning. It is published twice per year. Please read the instructions carefully for details on the submission of manuscripts, the journal's requirements and standards.

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- Each table should be placed on a separate sheet.
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**Co-authors**

| Print name | Signed | Date |
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