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.

Articles types published by Journal of Problem Based Learning include:
- Original research of all designs and methods, 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. Data collection should have taken place within five years of submitting the manuscript.
- Systematic reviews of research evidence relating to the above
- Scholarly papers presenting in-depth analysis and discussion of philosophical, theoretical, conceptual related to PBL, critical thinking, e-technology, e-learning, etc.

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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Savin-Baden in this edition of the journal argues there is a lack of definition and differentiation in the models of Problem-based Learning (PBL) in use globally and therefore PBL is not delivering on its potential to produce wise learners who value uncertainty and different ways of knowing, challenge the status quo, and bring about transformational change in themselves and society. She postulates that this has come about as a consequence of the practice of “tracing” other models of PBL without critically examining the discipline and cultural context of the curricula. She also argues that the current emphasis on quality assurance and risk management in Higher Education, together with curricula bound by templates and knowledge and skills-based outcomes, result in restrictive and repressive curricula.

Instead, Savin-Baden proposes that PBL should not be defined as a “method” but as a set of concepts and principles that leads to a pedagogy that promotes wisdom, uncertainty, and ecologies of learning that encompass “co-construction of meaning, deconstruction of knowledge and learning spaces that are both formal and informal”. The concepts of liminal tunnels where learning results in transformation of self as a person, professional or learner is also central to her thinking. However, the final concept of “PBL as constellations” provides a way of describing different approaches used in PBL that provide flexibility and could inform design and implementation decisions when aspiring to and applying creativity and developing a context specific PBL curriculum.

Finally, Savin-Baden offers a set of practices for the rethinking of curriculum making as “assemblage”: Mustering, folding and mapping; and consideration of the key questions:

What knowledge is of most worth?
What might a flexible curriculum look like?
Should we consider facilitators as fools?

Savin-Baden has indeed provided a paper to challenge the conventional wisdom, invite us as curriculum developers to think outside the boxes, be creative and transformational, that is to apply the concepts of PBL to our curriculum development endeavours. She mentions...
Stenhouse’s (1975) focus on curriculum intentions; by this she is alluding to his reference to society’s beliefs about the sort of individual that is valued within the community. She highlights the learning processes; these she suggests are paramount in accommodating creativity in the learning journey. Hence the role of the facilitator is crucial in managing learning processes rather than functioning as a content expert. By suggesting that facilitators need to be regarded as ‘fools’ in the Shakespearian sense ie “wise fools” who “are used to comment on society and to present a different world view”, she seems to be highlighting the enormity of the change required in the demeanour and style of the manager of learning situations if they are to fulfil the role of provocateur. Individual teachers will have their own ‘style’, but all members of a team need to appreciate what changes they are trying to produce in their students.

Given our aspirations for PBL as transformative learning, it is important to question the rationales for our own decisions and ask whether we are using the philosophical underpinnings of PBL to liberate learners and teachers on their quest for greater creativity. How do the curriculum development team members ensure that the needs of learners remain central to their thinking? How does one also make decisions as suggested by Stufflebeam (2003) on matters related to the context of education and the relevant professional practice, all the features of design or input, good governance of the implementation process that does not stifle aspirations for creativity and finally that the product (graduate outcomes) match the intent (goals) of the program.

Learners and teachers are only two of a number of stakeholders (Weiss, 1983) in the curriculum design and implementation processes. Other decision-makers or people who are impacted by decisions on processes and outcomes, for example in health services these include representatives from regulatory, industrial and professional bodies, health care providers as prospective employers and consumers, either as learners or others as recipients of professional care. There are also a number of ‘hurdles’ to overcome as we meet ‘prescribed standards’ within the internal and external processes of curriculum approval. Different stakeholders will have different ‘concerns’ on which to focus. Raising and addressing any of these concerns has the potential to confound aspirations for creativity.

In our experience, addressing concerns of all stakeholders often has the potential to add value to the curriculum design and outcomes. However, the key to mutual understanding of ‘intentions’ derives from a willingness to find ways of ensuring that we can actually demonstrate elements and outcomes within the student experience of both learning and practice. Hence existing students and graduates play a key role in accreditation processes. They are central to modelling outcomes of curriculum processes. At the time of curriculum accreditation and review, showcasing actual learning processes has the potential to demonstrate PBL concepts and principles in action. In our experience the student/graduate who confidently and competently responds to questions and asks more questions in return is the student who is more likely to safely respond to novel situations in actual practice; they have fully embraced the enquiry and lifelong learning processes that are central to PBL.

REFERENCES


What Are Problem-Based Pedagogies?

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Since its inception in the 1980s, problem-based learning (PBL) has developed in diverse ways worldwide, yet there has been relatively little mapping of its theories, practice, or disciplinary differences. This has led to confusion within the academic community about which constellation to adopt, or what would be the best fit for a given curriculum. The argument of this paper is that many PBL curricula focus on ‘tracing’ and ‘tracing over’ other forms of PBL, yet what is needed is a shift toward imaginative curricula. It will explore where PBL curricula are we now, what is getting in the way, how and PBL pedagogies might be re-delineated.

Keywords: Pedagogies; Quality; Curriculum; Assemblages; Flexible pedagogies

INTRODUCTION

Problem-based learning (PBL) remains a contested area of pedagogy, practice and research. While PBL is still undergoing a process of change worldwide, such change has been analysed by few in the field of higher education. Yet there is relatively little understanding of the different forms of PBL and the terms of inquiry-based, problem-based, and enquiry led learning. Despite the number of programmes that use it globally, many people still seem to be muddled about the use and relative value of scaffolding learning. Furthermore, recent research into PBL Savin-Baden (2016) seems to ‘always engaged’: texting at dinner or driving illegally while ‘facebooking’. It remains unclear as to whether digital tethering and (too much) digital influence are resulting in learning and engagement imbalances. Students might be spending too much time in virtual spaces or being distracted by messaging each other in lectures. Alternatively, young people might be over influenced by virtual realities and immersive virtual worlds.

The difficulty with all of these concerns and interesting virtual spaces is that largely we are unaware of their impact, whether too much fuss is being made or whether digital media really is affecting students’ engagement, learning and concentration. Although there continue to be debates and discussion, more recent research suggests that young people (12 -18) and students at university are aware of the impact and dangers, as well as the value of technology, to their lives. Perhaps instead there needs to be an appreciation of ‘useful tethering’; tethering that can be harnessed for learning and engagement. This in turn will mean that staff will become new pedagogical designers and who create and manage liquid and complex curricula for the 21st Century. Digital tethering would seem to offer students choice about how they use information, how they share it with others (or not), the way they learn together or apart, and how they support each other in ways that current classroom practices often prevent or discourage.

What is getting in the way?

Problem-based learning is a broad field of learning, practice and inquiry that encompasses and even encourages difference, which seems at many turns to be hampered by ideas about what a curriculum should be, and how it should be managed. This is seen in over-managed and over- designed curricula, such as:

www.ejpbl.org
The noise of dominant narratives

It is expected by many university managers that the imposition of staff and students’ charters will produce better behaved students and academics. Furthermore, keys and passwords in university life increasingly limit freedom and access to what should be seen as civic spaces, such as university campuses, buildings and libraries. The idea that civic spaces can be patrolled best by controlling movement and limiting access illustrates that spaces such as these are seen as products where risk must be minimized, disruptive intervention avoided, and the possibility of construction of new civic spaces limited.

To challenge, question or query the dominant narratives, the status quo, the way things are expected to ‘be’ in higher education, can result in marginalization, in being a lone or unheard voice, and can also result in a sense of difficulty. Not supplying a bibliography to students, standing against the research and teaching measurement frameworks or arguing against quality practice would be seen by many academics as being impossible at worst and subversive at best. We need to see the university, and indeed learning, not just as a space to be filled with content, but as a space for the harnessing of technology and useful systems for pedagogic ends, not the other way around. We need to examine the digital flow in people’s lives and how they reshape ‘things’.

Striated curricula

It appears that apart from the kind of education that occurs in the Liberal Arts colleges of the USA, most curricula world-wide are striated. These curricula are characterised not only by a strong sense of boundedness through the traditions of the discipline and their signature pedagogies, but also by university structures and procedures, exemplified in pedagogies of repression. Such striated systems mean that learning spaces are diminished, and personal engagement with such spaces is often demeaned by others. Dialogue, writing and reflection are not only undervalued, but also viewed with quiet contempt, as being privileged, utopian spaces.

The increasingly striated and stratified university sector is trying to rebuild itself amid the surrounding forces of civic disengagement, marketization and pernicious ideologies that threaten its very being and purpose. Today’s curricula, even those that are problem-based, are characterized by a strong sense of organization and boundedness. The consequence is that learning has become delineated by course attendance, defined learning places and set texts. Such striated systems mean that learning is narrow, overmanaged and uncritical. Rather than adopting a notion of curriculum whereby standardized designs are used for all disciplines, instead curricula should be designed with troublesome knowledge as the centre point and not the counter point. Although it could be argued, in the UK at least, that such creative curricula do exist, it would seem that they are located either in the shadowlands or not presented as transparently as they might be, in order to avoid the scrutiny of those from the behavioural end of the quality assurance (insurance) camp. Central to the creation of these narrow curricula are dominant narratives that pervade the higher education landscape.

Pedagogies of repression

Giroux (2016) argues that we need to move beyond pedagogies of repression:

At a time when the public good is under attack and there seems to be a growing apathy toward the social contract or any other civic-minded investment in public values and the larger common good, education has to be seen as more than a credential or a pathway to a job, and pedagogy as more than teaching to the test.

Pedagogy is not just a set of strategies and skills. It is not just a technique or method, but it should be something that brings to the fore relationships between knowledge, authority and power. Following Giroux (2016) I believe PBL pedagogy should:

- Raise questions, such as what knowledge is of most worth?
- what does it mean to know something?
- Emphasize critical reflection as a means of bridging the gap between learning and everyday life
- Embrace the idea that pedagogy is not about receiving knowledge but transforming it
- Enable students to explore the relationship between knowledge and power

The problem-based learning of the 21st Century needs to move away from standardisation, striation and repression; it needs to move out of the shadows.

Quasi quality?

We need to rethink pedagogy and move away from quasi pedagogy and quality. The challenge we face is that despite efforts to establish problem-based learning as a legitimate approach to learning, uncertainty still prevails about the most effective way to implement it, with the result that new models, approaches and conceptual frameworks continue to emerge. The brinkmanship we face is the codification of staff and students’ lives through signs, signposts and maps. These are characterized by benchmarks, and quality committees led by administrators who attempt to tame learning.

Quality, credit transfer and standards are all tightly bound within the current system and held on to by tenacious academics.
Institutions that will engage only with managed risk, are concerned about their student retention and contentment, and are worried about being lambasted by the local competition (the university up the road). At the same time, they are afraid of the quality agencies and funders, and as a result have become increasingly managed by bureaucratic administrators, who insist on courses being run in particular, and invariably inflexible, ways. A prime example was the need for a UK-based horticulture diploma to begin in September even though it needed to coincide with the growing season, beginning in March.

METHODS

What are Problem-based pedagogies?

Mapping PBL pedagogies (as has been done in the past) results in many ways in an oversimplification of the complexity of curriculum making. What I suggest we need instead are to explore components and concepts that together can begin to build pedagogies for PBL.

These need to be ones that provoke new ideas, imagine other futures and blur boundaries. We need to recognize and remember that there is no ‘gold standard’ PBL.

PBL Pedagogy as wisdom

The concept of wisdom has received attention since the ancient Greeks sought to discover its basis. For example, in the 5th and 4th Century BCE the Sophists became the first to consider the epistemological question, ‘what is the nature and reliability of human knowledge?’ The Sceptics in this tradition believed that the human mind was incapable of taking in knowledge without distorting whatever it perceived or conceived. The metaphysical perspective peaked during the 5th and 4th Century BCE, when the trio of Socrates, Plato and Aristotle fundamentally changed views of knowledge acquisition. Socrates, the first of these famous Greek philosophers, believed knowledge was unattainable. To prove his claim, he used dialogue and questioning approaches to probe student understanding of moral concepts such as justice and applied formal logic to their ideas to show inconsistencies, inadequacies and weaknesses of their beliefs. He wanted students to think harder and search to discover truth within themselves. His method evolved into the current notion of the Socratic method or Socratic dialogue. This questioning and probing of assumptions and beliefs is inherent in research methodologies today, but often the whole issue of wisdom is side stepped.

PBL Pedagogy as uncertainty

The concepts of uncertainty and liminality have not yet been

PBL pedagogy as ecology

The concept of learning ecologies seems to draw on the work of Bateson (1972) who saw the mind not as just something cognitive but rather as a network of interactions between the individual, the society and the universe as a whole. It also relates to more recent work such as Guattari (2000). Guattari argued that we have a narrow definition of ecology and this needs to be broadened to include ‘ecosophy’ which are three interrelated ecologies of environmental, mental and social worlds. Learning ecologies, whilst narrowly defined in some areas of higher education, can be said to draw on wider environmental, political and individual concerns about being human and what it means to learn. This is important in the context of models of learning that fail to recognize students’ experiences of becoming stuck in learning. It is suggested here that liminal ecologies of learning, the recognition of stuckness and the subsequent liminality is vital for students’ development and growth towards becoming flexible and fluent learners. In the context of PBL, ecologies of learning comprise forms of learning in which the learner co-constructs meaning, deconstructs knowledge and locates identity within learning spaces that are both formal and informal.

PBL pedagogy as liminal tunnels

The liminal tunnel, as described by Land, Rattray and Vivian (2014), begins with a portal or gateway triggered by the threshold concept or disjunction. Learners move through the tunnel through the liminal - space and emerge with a shift in learner subjectivity, a discursive shift, or a shift of a conceptual, ontological (such as identity shifts) or epistemological nature. Land et al (2014) depict this transformation as a cognitive tunnel where the liminal space within the tunnel is entered when triggered by a threshold concept, or a ‘disjunction’, that challenges previously held ideas about something. Disjunctions are ‘spaces’ or ‘positions’ which are reached through the realization that knowledge is troublesome. For instance, after encountering a threshold concept, the learner will move into a liminal space that can be transi-
tional and transformational. Learning in the liminal space often entails oscillation between different states and emotions. The liminal space is characterized by a stripping away of old identities, oscillation between states and personal transformation. In a recent study (Fredholm, Henningsohn, Savin-Baden, & Silén, 2019) data were analysed using the theoretical representation of the cognitive tunnel Land et al. (2014). Students’ narratives in PBL curricula described their disjunction, their experience of the liminal spaces and their resulting shift over the thresholds. Instead of focusing on a cognitive tunnel as Land et al. (2014) suggest, this was related to a particular practical experience functioning as a trigger for moving into the tunnel, learning in the tunnel and coming out ‘on the other side’ of the tunnel with a changed view. The driving forces for movement through the tunnel were the students’ inner motivations for learning, originating from the perceived meaning of the practical experience. The self-evident nature of the practical experience, and the need to master these situations created movement and transformational learning. Table 1 depicts movement into, through and out of the tunnel with triggers and consequences.

Insert Table 1. Depiction of movement into, through and out of the tunnel

It is proposed here that the liminal tunnel is not merely cognitive as Land et al (2014) initially suggested, but ontological and rhizomatic. Ontological engagement with the liminal tunnel is concerned with shifts in identity and subjectivity, rather than just cognitive shifts; it is more than working through and solving a cognitive problem. It is also rhizomatic because the options for moving in, though and out of the tunnel are complex and multi-faceted and require an examination of one’s learner identity and learning ecology.

**PBL pedagogy as constellation**

There are many constellations of PBL, each affecting the possibility for flexibility within the curriculum. This has led to confusion within the academic community about which form of PBL would be the best fit for a given curriculum, since it is an approach to learning that is affected by the structural and pedagogical environment into which it is placed (that is, the discipline or subject, the instructors, and the organization). In some areas, possibly most notably in some medical curricula, there is a sense of performative rules about how PBL should be used, but instead it would seem that we need pedagogically informed guidelines. Performative rules define how learning should be and the ways that knowledge should be presented, whereas pedagogically informed guidelines do not adopt such a narrow stance, and instead offer curriculum flexibility and a broad interpretation of professional body guidelines.

The growing number of constellations of problem-based learning illustrate the value placed on this approach to learning. The idea of locating different formulations of PBL as a series of constellations develops the idea that there is a broad range of PBL approaches. It helps us to see that there are patterns not just within the types of PBL but across the different fields of practice, as exemplified in Table 1, Savin-Baden (2014). The idea of grouping PBL approaches in this way is drawn from Bernstein (1992), who argued for the use of constellations as ‘a juxtaposed rather than integrated cluster of changing elements that resist reduction to a common denominator, essential, core or generative first principle’.

Insert Table 2 Constellations of PBL.

**Rethinking PBL curriculum making as assemblage**

Assemblage is not something that is created form discipline-based pedagogies professional guidelines and dictates form quality committee but the merging and emergence of creative pedagogical ideas and practices. It involves the process of mustering, mapping and folding. Deleuze and Guattari (1988) argue that assemblages occur through the process of selection, composition and completion of a territory. A territory in this case is a

| Table 1. Depiction of movement into, through and out of the tunnel (Fredholm et al, 2019) |
|---------------------------------|-------------------------------------------------|-------------------------------------------------|
| Moving into the tunnel: experiencing disjunction | Disjunction in the form of an ontological experience | Feeling confused, stuck and frustrated. Experiencing challenge to previously held beliefs. |
| Learning and developing within the tunnel while being in the liminal space | Movement triggered recognition of need to learn and shift | Transitional learning and sometimes transformational learning |
| Moving toward the end of the tunnel and crossing the threshold: the shift | Movement triggered by a sudden or gradual understanding, a stripping away of old identity, and personal transformation | An ontological shift evident in change in any or all of personal, professional, and learner identity |
| Exiting the tunnel | Confidence gained through threshold shift | Seeing the world afresh and valuing the disjunction and subsequent shift |
Table 2. Constellations of PBL (Savin-Baden, 2014)

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<thead>
<tr>
<th>Constellation 1</th>
<th>Constellation 2</th>
<th>Constellation 3</th>
<th>Constellation 4</th>
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<th>Constellation 6</th>
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<th>Constellation 9</th>
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<tr>
<td>Problem-based learning for knowledge management</td>
<td>Problem-based learning through activity</td>
<td>Project-led problem-based learning</td>
<td>Problem-based learning for practical capabilities</td>
<td>Problem-based learning for design-based learning</td>
<td>Problem-based learning for critical understanding</td>
<td>Problem-based learning for multimodal reasoning</td>
<td>Collaborative distributed problem-based learning</td>
<td>Problem-based learning for transformation and social reform</td>
</tr>
</tbody>
</table>

**Problem type**
- Designed to promote cognitive competence
- Designed to promote learning through activity
- Project-led
- Practical resolution
- Design-based
- Knowledge with action
- Managing dilemmas
- Defined by team in relation to practice
- Seeing alternatives

**Level of interaction**
- Solving of problems
- Management of problem
- Team learning and practical action
- Practical action
- Activity-focused
- Critique of knowledge, skills and context
- Taking a critical stance
- Critical Collaboration across boundaries
- Exploring and deconstructing structures and beliefs

**Form of facilitation**
- Directive
- Activity-focused
- Project management
- Guide to practice
- Project management
- Coordinator of knowledge and skills
- Orchestrator of learning opportunities
- Enabler of group reflection
- Decoder of cultures

**Focus of assessment**
- Testing of knowledge
- Competence for the world of work
- Project management
- Competence for the world of work
- Design critique and professional capabilities
- Use of capabilities across contexts
- Integrate capabilities across disciplines
- Self and team analysis
- Flexible and student-led

**Example paper**
- Alamro & Schofield (2012)
- Hayashi (2013)
- Ng, Bridges, Law & Whitehill (2013)
- Good, Howland & Thackray (2008)
- Beaumont (2012)
- Chan, Bridges, Doherty, Ng, Jin, Sharma, Chan & Lai (2015)
- Savin-Baden, Bhakta & Burden (2016)

---

Figure 1. Mustering, Mapping and Folding

Mustering
- The notion of *Mustering* disrupts the idea of curriculum as straightforward, since a fold allows for recognition of valuing of distinctions, discontinuities and labyrinths. It interrupts the idea of outcomes of objectives as the force for pedagogical design. Mustering means there is disruption between the idea of an inside and an outside so that inside and outside are both inside and outside to reiterate a fold always fold within a fold. Deleuze (1993) just as students learning and lecturers live inside and outside the university, so do the curriculum-makers. Our curriculum-making as straightforward, since a fold allows for recognition of valuing of distinctions, discontinuities and labyrinths.

Mapping
- It is a term often used to gather tools for battle and it has resonance here in that curriculum makers gather themselves and their students. It is a process of Mustering, Mapping and Folding as illustrated in Figure 1 and explained below.

Assemblage
- folding
- _Folding_ disrupts the idea of curriculum as straightforward, since a fold allows for recognition of valuing of distinctions, discontinuities and labyrinths. It interrupts the idea of outcomes of objectives as the force for pedagogical design. Folding means there is disruption between the idea of an inside and an outside so that inside and outside are both inside and outside to reiterate a fold always fold within a fold. Deleuze (1993) just as students learning and lecturers live inside and outside the university, so do the curriculum-makers. Our curriculum-making as straightforward, since a fold allows for recognition of valuing of distinctions, discontinuities and labyrinths.

Muster
- Folding
- The notion of *Folding* (Deleuze 1993) disrupts the idea of curriculum as straightforward, since a fold allows for recognition of valuing of distinctions, discontinuities and labyrinths. It interrupts the idea of outcomes of objectives as the force for pedagogical design. Folding means there is disruption between the idea of an inside and an outside so that inside and outside are both inside and outside to reiterate a fold always fold within a fold. Deleuze (1993) just as students learning and lecturers live inside and outside the university, so do the curriculum-makers. Our curriculum-making as straightforward, since a fold allows for recognition of valuing of distinctions, discontinuities and labyrinths.

Folding
- There is a sense at this stage of curriculum creation of living and working with order and chaos simultaneously. What emerges is an appreciation that what seems to be a complex, disrupting, changing, and fluid situation is fixed, but is a complex, disrupting, changing, and fluid situation.

Flexibility
- Flexible and student-led
- _Flexibility_ disrupts the idea of curriculum as straightforward, since a fold allows for recognition of valuing of distinctions, discontinuities and labyrinths. It interrupts the idea of outcomes of objectives as the force for pedagogical design. Folding means there is disruption between the idea of an inside and an outside so that inside and outside are both inside and outside to reiterate a fold always fold within a fold. Deleuze (1993) just as students learning and lecturers live inside and outside the university, so do the curriculum-makers. Our curriculum-making as straightforward, since a fold allows for recognition of valuing of distinctions, discontinuities and labyrinths.

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PBL curriculum need to assemble and map, not trace or trace over. There are no reusable learning objects here, instead it requires a process of Mustering, Mapping and Folding as illustrated in Figure 1 and explained below.

PBL curriculum need to assemble and map, not trace or trace over. There are no reusable learning objects here, instead it requires a process of Mustering, Mapping and Folding as illustrated in Figure 1 and explained below.
Mapping

Changes in technology have meant that cartography has a role both in the creation of physical maps as well as in the graphical presentation of geospatial information about the environment and people. Curriculum makers are cartographers who collect, represent and create curricula. Yet they are there to trace or trace over curricula but rather to create curricula that at times troublesome and messy, and at other times that are tidy, manageable and managed.

Curricula are like maps, they can be interpreted in a myriad of ways and it is important to recognise that they are not necessarily (and often not ever) portable across contexts and cultures, but often may not be.

Creating curriculum assemblages

The questions then is how do we begin to create curricula through creating assemblages? One of the central difficulties in higher education that faculty are provided with templates, criteria and guidelines about what curricula should be and should look like. These restrictions result in highly defined and delineated curricula which prevent the creation of new forms of curricula. Assembling curricula should not be ‘templated’ but instead consider:

• What knowledge is of most worth?
• What might a flexible curriculum look like?
• Should we see facilitators as fools rather than teachers of defined knowledge?

What knowledge is of most worth?

What is missing from the arguments and formations of knowledge and knowing is not only the way in which the spaces between these forms of knowledge are managed, but also what it is that enables students and staff to make the connections between all of them. It might be suggested that the missing links here are disregarded forms of knowledge, for example. The concept of disregarded knowledge encompasses knowledge often equated with emotional intelligence, such as when and how to use self-promotion, when to keep silent and when to intervene, but also with Haraway’s (1991) concept of responsible knowledge – the need to take responsibility for the position from which we speak. Disregarded knowledge is neglected because it lacks status in academic life and is just that – disregarded. The question is how do we ‘teach’ disregarded knowledge? Can PBL provide a space for the recognition and learning of these kinds of knowledge? Epistemology, and indeed higher education of the 21st Century would seem to be neglecting a whole area of knowledge, that of knowing people, since:

pressures to prepare students for employment often conflict with the desire to develop their critical faculties and to encourage them not only to participate in the production of knowledge, but to believe, too, that if they want to, they can change things (Taylor et al., 2002).

Yet to rethink our conceptions of knowledge or even knowledge what is needed are flexible curricula.

What might a flexible curriculum look like?

Despite moves, in the UK at least, towards flexible pedagogies, considerable resistance does seem to remain. The question is then how teachers might create flexible pedagogies that enable students to develop their own learning ecologies. Barnett (2014) has argued for 15 conditions of flexibility, which he believes will promote flexible provision in higher education as well as ensuring educational integrity. He argues that programs should lead to a qualification that contributes to major awards and offer all students access to suitable materials and with real-time interaction with tutors and other students. As well as other sound suggestions he argues, importantly, that programs should contain sufficient challenges so that students are likely to be cognitively and experientially stretched and to be informed by a spirit of criticality appropriate to each stage of a program of studies.

If flexible pedagogies are to be adopted that focus on human beings, as Barnett (2014) suggests, then the use of behavioural objectives needs to be dismissed in favour of Stenhouse’s (1975) learning intentions. The idea of conditions of flexibility is a challenge in the face of claims by staff that students remain entrenched and still want to be given lectures and write essays – despite little reflection from academics about how students may have become quite so entrenched in the first place. Some of the questions that need to be asked in the context of a desire for flexible pedagogies are:

• Why are objectives still useful?
• What are the boundaries and borders of a discipline and who decides?
• To what extent does credit transfer and modularity result in flexibility?
• What are the most effective ways of ensuring quality?
• How can shifts be made away from quality standards and professional bodies that are risk averse?
• To what extent are disciplinary norms and learning outcomes useful in the 21st Century?
• How can institutions become ‘unmanaged’ by bureaucratic administrators?

A curriculum should be a creation and a composition, a thinking space that is complex and multi-layered. Perhaps learning and the development of fluency in learning demands the ability to
live and learn liminally. Such gaps and thinking spaces are not narrow and linear, but complex, multidirectional and multilayered, similar to Corner’s (1999) mapping practices which he names: drift, layering and rhizome. Such curricula will encourage rhizomatic travel since the curriculum itself is a liminal learning space.

Facilitators as Fools

Shakespeare portrays fools as clowns or court jesters. To see facilitators as fools in a Shakespearean sense is to see them as wise-fools, such as Touchstone of As You Like It, Feste of Twelfth Night, and King Lear’s unnamed Fool. Such fools (or court jesters) are generally seen at a simplistic level as pointed satire, but in fact they are used to comment on society and to present a different world view Ellis (1968). For example, Feste throughout the play (Twelfth Night) never really shows us what he stands for, instead shaping his behaviour according to the context. Viola, a character in the play, remarks about Feste that ‘This fellow is wise enough to play the fool, and to do that well, craves a kind of wit.’ (Act III.i.53–54). She realizes that a good fool must be able to judge mood and personality, knowing when to challenge and when to be silent. Feste is skilled both as a fool and as one of the play’s most intelligent characters.

Stengers (2005) suggests that the idiot (or in this case fool) is one who ‘resists the consensual way in which the situation is presented and in which emergencies mobilize thought or action.’ Facilitators as fools reflects Giroux’s idea that teachers need to interrupt norms, change the processes of interaction and move away from the idea of just finding a solution.

The facilitator as fool prompts students to engage in imaginative and inventive problem-making and prevent the sanitisation of pedagogy. Facilitators need to be background noise who are both absent and present in their role and who make knowledge seem troublesome.

DISCUSSION

Emphasis at the moment at ‘what works’ in PBL this is epitomized in the focus on quality and containment. The result is that there is a tendency to ignore the ‘not-yet-ness’ Collier and Ross (2016) of curriculum making. Problem-based learning pedagogies must educate people to challenge dominant narratives and shift away from seeing education as merely training. Instead PBL needs to inspire passion for learning, justice and radical imagination. What we need to be asking ourselves is whether PBL is an emerging pedagogy and an emerging practice, and I suggest it needs to be both. Perhaps PBL needs to be seen as post-pedagogy, as learning as unbundled, as something that no longer largely takes place within educational institutions, but instead includes some of the following practices:

- Mentors: using mobile devices to keep in touch with parents or other significant adults in order to get advice, feel supported or use as a sounding board through WhatsApp or Facebook messaging.
- Gaming: alone and together to share, teach, learn, offer advice, negotiate, and give and receive hints, tips and solutions.
- Co-operative online learning: supporting and guiding each other about homework, assignments, exam revision.
- Teaching technology: sharing and teaching each other about apps, new devices and helpful sites.
- Emotional learning: using digital media for peer to peer support to manage personal challenges and difficulties, and to receive advice.
- Playful learning: trying things out and fiddling around, in order to experiment and discover.
- Co-production: creating presentations together, making and creating posters, mashups and vidding.

Problem-based learning needs to be a pedagogy of imagination and surprise: one that values critical engagement and diverse ways of seeing the world and challenging dominant narratives. Facilitators should not be call-centre teachers who just answer questions according to the disciplinary rules and company (institutional) policy.

What research needs doing?

This stance towards PBL pedagogy means that new research needs to be undertaken that promises to ensure that PBL does not become a pedagogy of repression. Questions could include:

- Which forms of PBL can help students to learn in ways that enable them to become?
- How can PBL be used to reduce/remove Pedagogies of repression?
- What is the impact of creating PBL curricula that are inventive?
- How can we ensure PBL is transdisciplinary?
- What is the impact of moving away from outcomes-based education?

CONCLUSION

Problem-based pedagogy should be about meddling with uncertainty, underpinned by wisdom so that students are encouraged to wrestle with difficulties that arise from the knowledge put before them. Pedagogy is more than the transfer of received knowledge from a disciplinary perspective. PBL pedagogy offers opportunities to enable students to have a will to learn, to engage with their passions and motivations and to see learning as an op-

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portunity to challenge, change and transform the world.

REFERENCES


Problem-Based Learning (PBL) in a Grade 11 World History Class: Trials, Tribulations, and Triumphs

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**Purpose:** The purpose of this work was to describe and reflect on the worth of the iterative design of a valid teaching method for senior school level social studies classes reliant on PBL methods.

**Method:** This descriptive reflection on the implementation of a Problem-Based Learning (PBL) activity involved a small elective class of ten Grade 11 World History students at Selwyn House School (SHS), in the Canadian Province of Quebec. Use of PBL was a five-step process, involving two different classes run concurrently, once with Cohort Group #1 (2017-18) in the spring of 2018, and twice with Cohort Group #2 (2018-19).

**Results:** PBL processes evolved through three PBL examples involving twentieth-century historical situations, beginning with World War Two (1939-1945) and concluding with the Cold War (1946-1991). Design features and processes demonstrated enhanced outcomes from student-centered learning.

**Conclusion:** The particular methods produced results that were evident in the students’ finished products.

**Keywords:** Problem-Based Learning; Evaluation; Constructivist; World History; Learning Strategist

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**INTRODUCTION**

Problem-based Learning (PBL) originated in a particular scientific field, so it is important to analyze whether the PBL methodology can apply to other fields. Branching out to rely on PBL philosophy and methodology in social studies is an option that continues to grow; there is a need to try to utilize this valuable learning and teaching tool. Other researchers such as Maxwell, Bellisimo & Mergendoller (2001) used the PBL medical school model (Barrows, 1986) to create their lesson plan to teach high school economics; by moving away from conventional teaching instructional approaches to one where “students formulate and pursue their learning objectives and select learning resources that are most appropriate to the problem they are seeking to resolve” (p. 73). Similar ideology applied to the PBL design for the Grade 11 World History class reported on here.

**PURPOSE**

The purpose of this work was to describe and reflect on the worth of the iterative design of a valid teaching method for senior school level social studies classes reliant on PBL methods. Due to the nature of the approach to learning, there was a need for the PBL implementation to become more evolutionary to integrate social studies and PBL. Through the alternative approach to learning and teaching within a modern Grade 11 World History class (1840-1991)
we continually reflected on the trial and efforts to implement PBL for a unit of study over a month of work during the academic year. The central question for the project implementers was ‘What are the benefits of a Problem-Based Learning (PBL) method for a senior school studies class?’ We envisaged that this methodology could also be a good Final Summative project for the end of the academic year.

BACKGROUND TO THE USE OF PBL

History does not have to be a boring subject. Through this approach, the goal was to foster more student-centered and experiential learning, encourage research, provide scaffolding, and allow for the presentation of a final product completed by students using elements of the PBL philosophy. Students were to study topics that interested them. This methodology could apply to other social studies classes such as Politics, Geography, Law, Contemporary World, Economics, or Current Events classes.

PBL is not a common learning method used by educators. A PBL approach tends to turn regular learning upside down because of the demands that students identify a problem of personal interest before given any instruction. The students must probe deeply into issues to find connections to develop solutions. The definition of the problem may change through their findings; all the while the student may take on different roles (Stepien & Gallagher, 1993). If we were to apply this method to a social studies content within a real-world application, this may include examples such as historian, geographer, lawyer, or politician, as they use many of the elements of PBL activities daily in work situations.

PBL, originally designed in Canada in the late 1960s out of the medical school at McMaster University (Hamilton, Ontario), showcased the nature of active learning (Hallon, 2011). The more student-centered, self-directed learning approach requires skills that imitate adult learning, and one can readily see that it is a valid method for emergency or case types of scenarios. PBL has been difficult to describe given the developments in the methodology. There is a suggestion that teachers may not always be necessary with PBL group work (Kilroy, 2004). The role of teachers changes in PBL but remains critical to learning.

The PBL process designed in this situation allows for the students to possibly come up with an end solution in terms of trying to answer a problematic question associated with their topic, complete research on their topic, and present a final product in a Final Summative Assignment. In other words, this PBL method attempts to be specific in design to incorporate some other active learning methods through the process and achievement of the final result.

LITERATURE REVIEW

The participants in this study were Grade 11 boys who all attend a private day all-boys Canadian Association of Independent Schools (CAIS) school located in Westmount, Quebec, Canada. Crocco, Cramer & Meier (2008) completed a study on gender, technology and social studies from 1987 to 2007. They showed that there was a limited number of studies on that topic.

Teaching history is not easy. Students seem to struggle with events from the past in terms of finding connections to the modern world; some students may wonder if history even matters. The use of teachers using textbooks that provide disconnected facts, ideas and dates make the likelihood of meaningful learning weak, given the linear or retrieval of fact approach (Misco & Patterson, 2009). History classes often provide too broad a coverage of content (Misco & Patterson). This criticism has encouraged history teachers to consider new ways to approach learning about the subject and concepts.

A constructivist approach was consistent with the chosen PBL method and it drew on ideas from past research on history teaching, suggestions for a reverse chronology approach (Simpson, 1983), and an issues-centered learning approach (Engle & Ochoa, 1988). These ideas assisted with our PBL design method. The use of the multiple steps in the PBL method were those used by Boniface (2011). It was designed as a scientific method and modified for this social studies plan.

A good review of the hundreds of PBL methods, albeit primarily medical, is provided by Barrows (1986). His review demonstrates that many research gaps exist around social studies.

PBL METHODS

Gender plays an active role in consideration of this design and method. The participants in this study are all Grade 11 boys who all attend a private day all-boys school. This PBL design involved a five-step process, with two different classes of ten students, run concurrently once with Cohort Group #1 (2017-18) in the spring of 2018, and twice with Cohort Group #2 (2018-19). Three PBL examples of stimulus material involved twentieth-century historical content, beginning with World War Two (1939-1945) and concluding with the Cold War (1946-1991).

PBL#1 and PBL#3 were similar in that they both dealt with the Cold War (1946-1991) and were summative activities at the end of the academic year. The PBL #2 material was World War Two (1939-1945) and, best classified as a warm-up for Cohort#2-PBL #3 as the PBL processes evolved for teachers. Grade 11 Modern World History class, encompasses the period 1840-
1991. It begins with the Victorian Era and runs to the end of the Cold War (1946-1991). Our mandatory Contemporary World-class for Grade 11 students, as dictated by the Quebec Ministry of Education, is a current events class that deals with modern social studies from 1991; that year involved the collapse of Communism in the Soviet Union and the internet invention.

The Grade 11 World History class is a full-year elective course option available for graduating grade eleven students at SHS. In the province of Quebec, Canada, students graduate after Grade 11: These boys are approximately 16 years of age. Cohort #2 (2018-19) was a stronger academic group than Cohort #1 (2017-18) in terms of academic achievement, work ethic, skills, and general interest in history as a subject. Ten students in each elective class enabled class reliable comparisons in reflections on student development associated with the PBL process.

The Province of Quebec, Canada, controls education; evaluation is competency-based. For example, two competencies here were Competency 1 (C1): Students will examine and interpret historical events using the historical method, and Competency 2 (C2): Students will construct consciousness of citizenship through the study of history. In Quebec, 60% is a pass; all twenty participants did pass. Figure 1 shows that marks were split evenly between both competencies for their Final Summative grade. For example, a grade of 50/60 would translate to mean 25/30 for each of the two competencies.

Originally a PBL guide through a PowerPoint was the tool used to introduce the PBL method to the students, and then the students followed through a number of slides that demonstrated what PBL is as a learning tool for students. Both Cohort Groups #1 (2017-18) and #2 (2018-19) were directed, through an on-going and teacher created Google Classroom, in the Grade 11 World History class, for resources, throughout both academic years, to review this new PBL teaching method. Cohort Group #2 (2018-19) practiced on World War Two (1939-1945) as the first of two PBL exercises.

The essential steps that all students followed were: 1. Meet the
Problem (What is the specific question related to the problem that you wish to analyze?); 2. List Ten (10) Known Facts plus List Ten (10) Unknown Facts as this area involves students researching their topic to fill-in-the-blanks about any questions associated with their topic; 3. Generate Possible Solutions; Choose the Most Viable Solution; and 4. Report Solutions. The students were expected to work through the steps and then present their findings to the class. The teacher gives some advice, whenever sought, or if necessary. The second step of Known or Unknown Facts could be considered a two-step process as the goal is that students will analyze their topic through the different research analysis of fact-finding. It is an important phase as it allows the students to delve deeper into their selected topic through research.

Completing a Mind-Map on a selected History Unit got students thinking about all the possible topics that they wished to consider. Then students added all the important historical events that they might want to consider as topics to begin the process. It is a great starting point, and a great segue into the next PBL steps that students will have to follow to complete the process. Hopefully, they would work out a topic of interest faster than if they did not have this sort of information. Students were also encouraged to consider creating their own Google Docs so that they could continue to add their information to the topic, while assisting them with their organization. The students were encouraged to add their teacher and the Learning Strategist educator, a collaborator, in this case, to the Google Docs; student progress could be monitored in this way. This class did not have a set Learning Strategist but SHS has an advanced academic program in which there are two Learning Strategists available as resources for the entire school if necessary at any time.

To ensure that students fully appreciated the Cold War period a list of nine possible topics was available to pique their interest. The introductory PowerPoint for this PBL activity included other topics - Yalta Conference (Churchill, Roosevelt, Stalin); VE Day; Hiroshima/ Nagasaki; Cuban Missile Crisis; Kennedy Assassination; Gold Standard; Vietnam War for Independence; Black Panthers; and Peace Movement and Counterculture. More topics were suggested as well through the included website https://www.historyonthenet.com/the-cold-war-timeline-2/ (Rank, 2016) at the bottom of the slide suggesting additional topics to encourage the students to continue to explore and find a topic of interest for their further analysis. The topic of study was theirs to choose.

PBL focuses on student learning in a hands-on way instead of memorizing facts. It also urges students to use high-level thinking skills, which require them to analyze, create, defend, or evaluate, and the useful website of https://www.queensu.ca/ctl/teaching-support/instructional-strategies/problem-based-learning from Queen’s University (Kingston, Ontario), to help students understand PBL. The evaluation (assessment) process can be reviewed and detailed in the second class; setting up the structure is important.

Results: Reflections on the Worthiness of Elements of Process Coincidentally, the number of students (ten in each cohort group) was exact, and this contributed to a valid means of comparison between the two groups. The diversity of analyzing different topics, associated with the broad Cold War (1946-1991) historical period, did make comparison difficult. Students were encouraged to analyze different topics as one of the only means of teacher-control for this activity to avoid repetition of information when students presented to their peers: This also made group comparison more difficult. However, the use of pairs or groups will be possible in the future, and will permit students or a class to focus on a specific history topic, event, or person.

A bigger challenge with this PBL design was with evaluation (assessment). In terms of peer evaluation, the attempt to prevent collusion amongst the boys was not easy and raised issues about the validity of this evaluation. Evaluations used throughout and in the final product presentation, were also challenging to determine what exactly we were looking for in terms of student learning. Both the collaborator (SHS Learning Strategist) and I evaluated the students for all of their final presentations. There were many times that we wrestled, edited, and disagreed with each other in the process of attaining the evaluation method that we sought to address students’ learning. Having students assess their learning was a challenge as it is difficult for students to reflect on how they may have grown through the process.

As any educator knows with peer evaluation, another challenge is ensuring that collusion is not present because it may be hard for a student to be critical of a friend. Deals can be made! The pattern was predictable.

Cohort Group #2 (2018-19) utilized two PBL methods through World War Two and the Cold War era; whereas the Cohort Group #1 (2017-18) only did one PBL with the Cold War unit of study. It was difficult to compare both classes, so the focus was more about student outcomes and student-demonstrated learning.

Cohort Group #1 (2017-18) students analyzed the Cold War topics – What is the impact of Glasnost during the Mikhail Gorbachev era?; Why did the Afghanistan War in 1980 occur?; What contributed to the Cuban Missile Crisis?; What is the impact of the Technological Advances of Nuclear Submarines during the Cold War?; The Space Race - why the Soviet Union failed over
time?; What was the impact of the Vietnam War- Resistance War against the USA?; Reaganomics - how it contributed to a new economic model?; What is the impact of the Chernobyl, Ukraine (1986), incident?; What were the United Nations Security Council Challenges with Controlling China after World War Two?; and How did the KGB Illegal's impact both Canada and the USA?

Topics were different; Cohort Group #2 (2018-19) analyzed the Cold War unit of study. Besides being a slightly stronger academic group, they had the benefit of having two runs at the PBL methodology, so this made for better final presentations. World War Two (1939-1945) presentations followed the same method, but the evaluation piece was brief and not heavily weighted in terms of impact. Topics included: What if Germany wins World War Two?; What if Japan did not bomb Pearl Harbor?; Why World War Two is the most complicated and most interesting topic to study, in history?; What military advancements around armored warfare occurred in World War Two?; How did World War Two contribute to espionage?; Why were the Allies well prepared for the D-Day Invasion?; What contributed to the Holocaust?; Why did Japan not surrender?; and What if there were not any medical advancements occurring in World War Two? One student did not present in this session for health reasons.

For Cohort #2 (2018-19), the selected topics for the Cold War by the ten students included: The Vietnam War: How could the United States have won the war?; John F. Kennedy and the connection to the Cuban Missile Crisis; Hiroshima and Nagasaki-How did it change the world?; What if The New York Times never published the Pentagon Papers?; Muhammad Ali- Why was there controversy with him?; What is the impact of the 1972 Summit Series in terms of impact on the political culture?; What is the impact of the Khmer Rouge Killing Fields in Cambodia; Who shot John F. Kennedy? and Could it have been avoided?; How did the British Invasion of the 1960s change music?; and What is the impact of the 1969 Woodstock Music Festival?

LESSONS LEARNED THROUGH THIS PBL METHOD

It was important for all the students to begin their PBL study with a question as it allowed them to focus not only on answering it, but also to consider the various alternatives to the question in terms of counter-arguments, or challenges that might exist. The process involved research, an analysis of historical perspectives about the issue; this is an important step to consider and, all students should begin with a PBL question to try to answer it as best they can. The critical thinking involved in this process is of value because the question encourages the students to think about the topic in a more diversified way; while understanding some of the complexity that can be associated with the particular question.

It is also important for a student to narrow the focus of a historical topic. For example, with the Vietnam War (1954-1973); 1954 is when the French were officially kicked out of Vietnam by the communist Viet Minh forces of North Vietnam, and 1973, was the year in which the USA President, Richard Nixon, officially withdrew the remaining American troops from Vietnam. Other historians may suggest that the war lasted from 1969-1975, given the intense conflict between the USA and Leader, Ho Chi Minh and the North Vietnamese, in this time, and 1975 as the final year when the South Vietnamese officially surrendered to communist North Vietnam. In 1976, Vietnam united the North and the South together as a Communist country. Students should be encouraged to narrow a focus with historical events that cover many years.

In terms of how the evaluation pieces changed, it was profound. It was necessary to devise a better method for Cohort Group #2. For Cohort Group #1 (2017-18), teacher evaluation was preferable, but two students evaluated each presentation. It was not as formal in intent, but notes were encouraged and a score out of ten expected. The two student evaluators were modified each time to encourage all students to complete at least one peer evaluation.

The evaluation piece was adjusted for Cohort Group #2 (2018-19) to be more formal, linear (in the sense of seeking connections), and diverse. All students in the group evaluated every presenter every time, allowing for at least nine evaluators for every presentation. A student self-evaluation form had to be completed by presenters; this was about their process and presentation, and both teachers completed an evaluation rubric as the student presentations occurred in real-time. In total, for every student presenter, there were three diverse forms of evaluation all weighted differently, and a total of 12 evaluations emerged for every student.

The PBL Essential Elements Checklist - Student Self-Evaluator (Figure 2) was used by students to immediately assess their presentation to the group and see connections with peer and teacher evaluations. The design of the student assessment form aimed for efficiency and ease of use; the presenter needed to check one of the boxes of Strongly Agree, Somewhat Agree, or Non-Existent for different criteria. This specific grade equivalency for each section was not provided to the student, ensuring they provided honest feedback about their presentation and the work that they put into the project. The teachers felt that this was an important
aspect to keep private from the students so that they would better reflect on their presentation without realizing there was a mark attached to each of the boxes, and thus encouraged a fair assessment for Cohort #2 (2018-19). The biggest problem we had with the Cohort Group #1 (2017-18) was the evaluation piece, so we were happy with the process, and many of the student presentations demonstrated good levels of learning (See Figure 3: Project Design Rubric - Grade 11 World History- 2017-18).

Project Design Rubric - Grade 11 World History - 2017-18 lacked specific criteria for each category. All evaluators assessed each presentation based on a rough estimate of the criteria to determine a sense of what grade the student deserved; it was not ideal for PBL; adjustments occurred for Cohort Group #2 (2018-19). Evaluators also tended to assess the presentation out of ten marks based primarily on whether the student presented ten points or facts. It needed work! One Rubric used for Cohort Group #1 (2017-18) - (Figure 3) was poorly designed, with four areas assessed and within each, there were different criteria.

The final evaluation chart for Cohort Group #2 (2018-19) (Figure 1) shows how the distribution of the final 60 marks: It was equally teacher and peer evaluated to make up 24 marks for each criterion, 48 in total, leaving the last 12 marks to the student’s self-evaluation. The aim was to have a balance between both the student peers and educators. The evaluators were the observers and, it seemed to make the most sense for validity and reliability to have these two areas of equal value. This evaluation method allows for balanced teacher and student-centered control. The student self-evaluation piece involved 12 of the 60 marks, and half of the teacher and peer evaluation pieces, to avoid the possibility of a student generously or more-harshly evaluating themselves. It also emphasized the importance for students to present their findings well to their audience, informing them
about their selected topic. Students used evaluation forms to conclude the process; they could also view the teacher’s comments.

From Figure 4, it is evident that the teacher’s evaluation for Cohort Group #2 (2018-19) was much more extensive in defining each of the criteria in the rubric. As the educator was in charge of running the class, the expectations for a more thorough and detailed evaluation method was necessary. All evaluation items were available to students before their presentations. Of the four, level 4 is a key student goal when they present.

The six criteria in this rubric were:

- Use of Research and Historical Connection (the student should demonstrate research skills that linked to facts, believable and referenced evidence);
- Appropriate Word Choice - spelling, grammar, and context (students should conduct a review of the final product in terms of editing);
- Required Elements for the Project (student completed and demonstrated all areas of PBL);
- Originality (in the design of the presentation);
- PBL Counter-Argument (the student was able to assess an argument that conflicts with the primary issue raised from their PBL analysis); and
- Final Oral Presentation to the Class.

Learning outcomes about their topic should be evident from their findings.

There is a direct correlation between the student’s evaluation method (Figure 6) and the Final PBL Evaluation Chart (Figure 1), for Cohort Group #2 (2018-19); one difference was that the students were encouraged to complete a Likert Scale in one and meet the criteria within a Rubric in the other. The intent was to make it easier for the students to simplify their grading and encourage them to complete peer assessment tasks. For Group #2 (2018-19), more detail was added for Group #1 (2017-18), as seen in Figure 5.

**INSIGHTS INTO PROCESSES AND OUTCOMES**

Cohort #2 in 2018-19 was successful as teachers were able to gauge progress on PBL on two occasions. Processes improved as we worked through and continually engaged with the students for ways to make learning better for them. Cohort #2 (2018-19), in comparison, with Cohort #1 (2017-18), were a little bit stronger as a group in terms of work ethic and achievements led to better results. It was a successful PBL tool for both groups as the majority of student presentations were well done, and demonstrated sound student learning. It was easier for students the second time: Outcomes were evident in the use of PowerPoint, the story-lines about their topic, bristle board presentations outlining their findings.

For Cohort #1 (2017-18) and Cohort #2 (2018-19), at least three of both student groups could be classified as showing merit, especially the less academically-inclined boys; 6-8 boys in each

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**Figure 4.** PBL Peer-Evaluation Form- Likert Scale.
cohort group completed sound PBL studies. One student did not complete the PBL methodology as well as they might have done. All of Cohort Group #2 (2018-19) presented well and validated PBL as appropriate for social studies teaching. Evaluation methods were tighter than those used for Cohort Group #1 (2017-18); the double method processes also involved a more comprehensive evaluation scheme. While the Cohort Group #1 (2017-18) results were also impressive, the limited easier evaluation method(s) curtailed full assessment of the PBL method. Some strong student outcomes were evident from Cohort #1 (2017-18) who were considered weaker than Cohort #2 (2018-19) based on academic achievement and skills demonstrated throughout the year. Their above average results may have been a result of an evaluation method that needed work. The Project Design Rubric, (Figure 3) was taken from another source, and was not PBL focused in design. Both teachers did not like the evaluation methods but the results indicated the need to try again the next year, formulating our own evaluation method and rubrics.

**Figure 6. Final PBL Grade 11 World History Evaluation Chart.**

**BENEFITS OF THE PBL METHOD**

One benefit of the PBL method was the use the School Learning Strategist as a collaborator to assist with the process. Constant contact was maintained in-person, over lunch meetings, through the use of Google Docs (so that we could continue to add information or contribute questions to the process), and via e-mail. When designing and implementing PBL, it was clear that working with a learning strategist made for a better product. Students had learning differences and the collaborator was familiar with this dynamic in his school role; he was able at times to direct the boys more with their specific focus to enhance their skills. Some of the boys were comfortable meeting in his office to achieve more clarity or ask questions.

The collaborator was valuable because he was a great sounding board, and his ideas shaped and contributed to this final PBL process. He evaluated all the presentations as I did; it was a great way to discuss each performance and to compare and
gauge our evaluations. There was only one student's evaluation that led to a dramatic difference between the two of us. Further discussion led to a consensus on the student's mark. Final summative evaluation pieces involved a total of twenty students, who presented their findings, so only one outlier is encouraging.

In terms of gender studies, as this teaching method was used exclusively on boys, it would not be fair to comment given that girls not part of our school. However, this method should be just as effective with female students. It was a successful method for the Grade 11 students, so the principles should work for any Grade 9 to 12 social studies class.

A benefit of this initiative was that students analyzed a diverse range of history topics, progressed their selected learning event/s and presented their findings to each other. Beginning with a problem-based question is a great place to start, and the step-by-step methodology was also valuable as it was not so difficult that a student could not work through it. Having different steps in scaffolding increased the student's learning through the completion of the necessary steps to get to a final solution. The building blocks were required to improve or layer the work.

The boys enjoyed the process as they worked through their topics. It was not uncommon for the students to modify or change their original choice after the process began. This change should be welcome because students, in this learning method, are to do their learning through analysis. I recall one student who wanted to study the Vietnam War (1955-1973), and discovered very quickly that he needed to modify his topic to be more specific with his analysis of why the United States may not have won the war? He learned very quickly that this is too broad, controversial, and it would be too deep for a proper analysis in the limited time that we have for this activity. He narrowed the focus to analyze his selected interest to look more specifically at US military strategies associated with the Vietnam War.

**CONCLUSION**

PBL methods can work well in History classes, and there is the possibility that this learning and teaching method be applied in other social study classes. Given the nature of social studies often involving conflicting interpretations, and the encouragement for
students to resolve what has contributed the most to impacting a debatable topic, this PBL design concept is beneficial. The students presented some comprehensive findings and frequently surprised us with their analyses, creativity, and knowledge about their selected topics. This method works well with male students, and the various steps contribute to an approach that encourages students to analyze a topic of their interest and learn more about it through a PBL method. PBL is a valuable option as a teaching tool. Using PBL twice a year enhanced the final product. The first PBL offering could have been quicker, and more about working through the process to understand it as we did with Cohort Group #2 (2018-19). The second run was all about student learning outcomes seen through a comprehensive finished product. The second run-through can also be incorporated as a culminating Final Summative activity to end the process.

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REFERENCES

Using Prompts to Scaffold Metacognition in Case-Based Problem Solving within the Domain of Attribution Theory

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Case-based problem solving is a core approach to foster knowledge acquisition, especially during the learning process by which novices become more and more expert within a domain. This study investigated whether metacognitive scaffolding leads to better learning outcomes compared to learning without such support in a case-based learning environment. In addition, we examined the interaction between prior domain knowledge and prior metacognitive abilities and skills. Within a one-factorial design, we explored the role of metacognitive prompting during the learning phase. A pre- and post-test were applied assessing knowledge acquisition, metacognitive skills, and cognitive load. Results indicate no main effects for prompting, and no interaction effect between prior knowledge and prompting. Metacognitive prompting enables learners that already possess metacognitive abilities to activate these during problem-solving and, thus, score higher in the knowledge post-test than learners with low metacognitive abilities and no metacognitive prompting.

Keywords: Metacognition; Prompting; Case-Based Learning; Hypermedia

INTRODUCTION

Self-regulated learning has become a central part in our modern society. Self-regulated learning can be seen as a proactive process that helps students to acquire knowledge and skills. Within this process, self-regulated learners set their own learning goals, they select and deploy adequate strategies and they are able to reflect their effectiveness. The crucial question is “whether a learner displays personal initiative, perseverance, and adaptive skill” (Zimmerman, 2008, p.167). The qualities of self-regulated learners contain from advantageous motivational feelings and beliefs as well as to metacognitive strategies (Hardy, Day & Steele, 2019; Zimmerman, 2008). With the increase of digital resources, different approaches and methods for fostering self-regulated learning have been developed, e.g. training, scripting or prompting. While most of these approaches directly aim on supporting learners on a cognitive level, more and more support for learning refers to metacognitions, as they are an important aspect of self-regulated learning (Hardy et al., 2019; Winne & Azevedo, 2014). Learner support within the cognitive domain usually refers to processes that support elaboration or direct information processing, rehearsal, etc. With the term metacognition, we refer here to either the abilities of learners or the advice to monitor and to adjust (cognitive) information processing before, during and after learning.

Supporting metacognition is particularly important in self-regulated learning. Zheng (2016), for example, found in this regard that a computer-based learning environment is ideal
for supporting self-regulated learning, but students still need supportive elements to scaffold their activities. A meta-analysis conducted by the same author found positive effects of self-regulated learning scaffolds, e.g. metacognitive support, on academic performance in computer-based learning environments (Reiser & Tabak, 2014; Zumbach, Rammerstorfer & Deibl, 2020). In addition, metacognition is crucial for successful problem solving as it regulates and directs any relevant problem-relevant cognitive processes (Hardy et al., 2019; Winne & Azevedo, 2014). Research on supporting metacognitive processes during computer-supported problem solving is still scarce, in particular in the domain of psychology (Bannert, Hildebrand & Mengelkamp, 2009). This study addresses the question of whether metacognitive scaffolding in computer-based and problem-based learning scenarios requiring students to solve a case-based problem on attribution theory leads to better learning outcomes compared to learning without such support.

**Metacognition as a crucial aspect of self-regulated learning**

Research in metacognition has become an important part in contemporary educational and instructional research. There are two major categories of metacognition (Winne & Azevedo, 2014). One category refers to the ability of learners to diagnose their learning process and outcomes (i.e., their “sensitivity” related to learning). The second category refers to the learners’ performance and is what they genuinely describe as metacognition. This includes, e.g. the knowledge and application of learning strategies. A more precise definition of metacognition is provided by Flavell (1979) who introduces the term of metacognitive knowledge. Metacognitive knowledge can refer to three domains or variables. The first one includes knowledge about the learner her- or himself (“personal variables”; e.g. knowledge about the abilities of a person, strengths and weaknesses). The second includes knowledge about the task a learner is confronted with (“task variables”, e.g. whether a task is judged as difficult or rather easy). The third aspect includes knowledge about information processing or problem solving strategies that might be applied, which ones are likely to be effective and which ones are rather not (“strategy variables”).

The use of cognitive strategies and metacognitions during self-regulated learning is crucial to learning (Eckhardt, Urhahne, Conrad & Harms, 2013). Self-regulated learners have to make important decisions about what to study when, whether to continue or terminate studying or how long they should focus on the specific learning material when studying. Learners with strong self-regulated learning skills are reflective, intentional, and autonomous learners who benefit from problem-solving (Greene, Bolick & Robertson, 2010). Unfortunately, as research has shown, students often fail to regulate their learning processes (Ohtani & Hisasaka, 2018). The activation and application of such strategies is rather poor. Students are often faced with severe difficulties and problems to regulate their own process and to find and apply appropriate strategies (Winne & Azevedo, 2014). With regard to cognitive and metacognitive strategies, students often fail to apply and maintain these strategies during self-regulated learning although these strategies would contribute to deeper learning and, thus, to higher learning gains (Bannert, Hildebrand & Mengelkamp, 2009; Reiser & Tabak, 2014). Wild (2005) differentiates cognitive strategies here between revision, elaboration and organization strategies. They differ from metacognitive strategies, because they refer directly to what learners do with the learning material. Metacognitive strategies do not directly refer to the learning material itself but rather a learner’s abilities to control his or her cognitive processes.

The use of metacognitive strategies in self-regulated learning scenarios is also emphasized within the conceptual framework for Problem-Based Learning (PBL) as suggested by Little and McMillan (2016). In this framework, metacognitive processing acts not only as helpful strategy for students within their learning progress and process but also as an assessment instrument for improving course quality and sustainability, especially within PBL-programs.

Metacognitive strategies help students to control their learning process. They imply planning, monitoring and controlling of the learning processes (Winne & Azevedo, 2014). Research assumes that regulation of cognition refers to better use of attentional resources, better use of existing strategies, and a greater awareness of comprehension breakdowns (Schraw, 1998). However, students are often not able to regulate their learning activities (Azevedo, 2009; Bannert & Mengelkamp, 2013) and thus guidance or instruction especially during learning situation with simulations is needed. Bannert, Hildebrand, and Mengelkamp (2009) argue that metacognitive support to increase student’s learning competence is more effective than systematic instruction.

Taken together, there is theoretical and empirical evidence that cognitive and metacognitive strategies contribute to sustainable self-regulated learning. As a central framework and theoretical model, Winne and Hadwin (1998) suggest that metacognitive processes in terms of control, monitoring, and evaluation are a core part of the cognitive system.

**Fostering metacognition**

As metacognition supports and enhances learning (Winne & Azevedo, 2014), the fostering of meta-cognition is one central
aim of instructional approaches. There are different approaches and strategies on how to do so. In general, these instructional strategies differ between direct and indirect. Direct approaches include training strategies, where learners are almost always given explanations about the nature of self-regulated learning, the nature of cognitive and metacognitive strategies and how these strategies can be applied. Usually these strategies are exemplarily applied within the training context. Such direct approaches aim to create awareness and knowledge about metacognition and usually train their application. Bannert et al. (2009, p.830) point out, that “(...) for students lacking metacognitive competence (so-called mediation deficit, e.g. Hasselhorn, 2006), direct training is necessary in order to extensively teach the metacognitive knowledge skills.” In a study by Koch (2001) a training of metacognitive strategies for reading comprehension was applied. Results revealed that the training was able to enhance reading comprehension and performance in a knowledge test compared to a group without training. While other research shows no impact of metacognitive training or even negative outcomes (Jing, 2006), metacognitive training that is additionally accompanied by incentives for using these strategies and continuous feedback on strategy use seems to contribute to learning (Miller & Geraci, 2011).

There are also indirect strategies where learners are not necessarily explicitly informed about metacognitive strategies themselves but rather are required to apply pre-given strategies. There are many ways to design this way of scaffolding, but one central way is to script learners’ behavior by providing prompts during a learning phase. These prompts usually require learners to fill in pre-given forms that include a specific strategy that has to be applied to the current learning task (“Please read the following text and formulate in two or three sentences what you understood and what you did not. Consider also what you need to know to understand the text completely.”). According to Lin, Hmelo, Kinzer and Secules (1999) prompting includes several strategies that might be applied during learning. These include process displays, process prompts, process models and reflective social discourse. Within the area of metacognition, the use of process prompts is one major approach of fostering learning. Bannert (2004) defines prompts as “(...) instructional measures integrated in the learning context which ask students to carry out specific metacognitive activities” (p.2). Using instructional prompts, the intention is not to teach new information, but rather “(...) support the recall and execution of student’s knowledge and skills” (Bannert, 2009, p. 140). Thus, students get precise instructions they should consider during the learning phase in order to draw attention on certain aspects of the learning process (Reiser & Tabak, 2014). Students who already possess metacognitive skills can also be supported by using these strategies. A study by Bannert and Mengelkamp (2013), for example, was able to show that prompting enhances students’ activation of learning strategies.

Especially within the area of multimedia learning, many studies relate to self-explanation prompts. This might be due to the fact that “self-explanation may be particularly well suited to multimedia learning because generated inferences form connections both within and between verbal and non-verbal representations” (Van Meter, Cameron & Waters, 2017, p. 188). Kim and Hannafin (2011) showed that metacognitive scaffolds (e.g. self-questions) could enhance learning with simulations and improve scientific reasoning and learning outcomes. Piksööt and Sarapuu (2015) found question prompts for supporting students’ self-monitoring of their own learning progress as an effective instructional approach.

Nevertheless, we have to note that this “metacognitive prompting” might be a misleading term. The prompting itself can fulfill two functions: To really activate metacognitive thinking processes (e.g. monitoring one’s own attentional processes), but also to act as a metacognitive process itself and activate subsequent cognitive processes. Thus, metacognitive prompting or scaffolding can enable both, metacognitive and cognitive processes (Reiser & Tabak, 2014).

However, additional support via prompting demands a certain amount of cognitive resources from learners. Berthold, Röder, Knörzer, Kessler and Renkl (2011) already found a double-edged effect of prompts, showing that besides positive effects on learning, prompts caused the cognitive load to reach the upper limit of working memory capacities, which is particularly detrimental in terms of procedural aspects. In addition, Bannert (2004) showed that this might be particularly problematic for students with lower prior domain knowledge, because they often struggle to use prompts in adequate ways.

Assessing metacognition

Assessment of metacognition and metacognitive processes involves different strategies and methods. During the 1980s, a number of different instruments with different methods such as the self-report inventory of students’ strategies LASSI (Learning and Study Strategies Inventory; Weinstein, Schulte & Palmer, 1987); a structured interview like the Self-Regulated Learning Interview Scale (SRLIS; Zimmerman & Martinez-Pons, 1988) or a questionnaire like the Motivated Strategies for Learning Questionnaire (MSLQ; Meijs, C., Neroni, J., Gijselaers et al., 2019) have been developed (see Zimmerman, 2008). The
MSLQ has been designed to assess different cognitive and metacognitive strategy use including planning, monitoring and controlling of one’s learning processes during self-regulated learning.

Supporting problem solving in case-based learning environments

As shown above, metacognition is a crucial aspect of self-regulated learning. In addition, metacognitive processes play an essential role for successful problem solving. A successful problem solver uses his or her cognitive and metacognitive skills for analyzing a problem, developing, choosing and applying a most likely successful problem-solving strategy, and evaluating one’s own progress and possible solutions (Ohtani, & Hisasaka, 2018; Winne & Azevedo, 2014). Effective problem solvers, i.e., experts in contrast to novices within a domain, show different problem solving strategies that make them effective. Experts usually have within their domain extensive schemata that are available for problem solving. Confronted with a familiar problem they can easily activate an existing problem-solving schema, adapt it to the current problem and, thus, solve the problem. Experts – compared to novices – spend more time on analyzing a given problem and usually rely on a forward problem-solving strategy by familiar problems (Boshuizen, Gruber & Strasser, 2020). Experts are able to control, to monitor, and to evaluate their own problem solving and, thus, use metacognitive strategies more frequently than novices (Richey & Nokes-Malach, 2015). Thus, prior knowledge or expertise seems to be a strong predictor of successful problem solving. Nevertheless, on the way to become a successful problem-solver, especially when solving cases, instructional support is helpful. Ertmer and Koehler (2014) were able to show that students benefit from case studies, when instructional prompts keep students focused on relevant details of presented cases. In a study by Harkrider, MacDougall, Bagdasarov, et al. (2013) the influence of case presentation and prompting has been examined. Results reveal that when cases are presented sequentially, prompts that ask learners to structure the learning material might contribute to better learning outcomes if the use of prompts is not exaggerated. When cases are presented simultaneously, unstructured prompts (e.g. asking for comparing cases for similarities) contributed to elaborated sense making strategies among learners. Taken together, the fostering of case-based problem solving by using scaffolding approaches seems to support learning processes when applied usefully and contributes to deeper learning than without such instructional aids (Kim & Hannafin, 2011).

Taken together, the theoretical models and empirical evidence provided so far let us assume that metacognitive processes, applied adequately, can foster self-regulated learning. While direct training of metacognitive strategies seems to be not as effective as more implicit approaches this research aims on analyzing the effects of indirect, scaffolded metacognitive support in an applied case- and problem-based learning environment. Such learning environments can usually be characterized to focus instead on ill-structured domains and to demand a high level of students’ self-regulated learning skills. We also assume that almost all students (especially in Higher Education) have already developed a more or less elaborated explicit and/or implicit set of self-regulated learning skills. Nevertheless, students often cannot or fail to activate these skills, especially during applied problem solving. Therefore, the following study has been designed in order to examine how students can be supported in activating (metacognitive) learning strategies by means of prompting.

Research questions and hypotheses

There is a body of evidence that prompting might support metacognitive processes that contribute to deeper and more successful learning processes (Bannert & Mengelkamp, 2013). Thus, we assume that the use of active metacognitive prompting should also foster the application of these strategies within a hypermedia-based problem-solving scenario when learning with cases. The term “active” means that such prompts are not completely determined but learners rather have to adapt pre-given strategies to the current learning material. We assume that learners in the prompting condition will demonstrate greater knowledge acquisition than learners in the non-prompting condition. (Hypothesis 1). As suggested by Bannert (2004), cognitive load can play a role when promoting metacognitive strategies and should be taken into account. We therefore further investigate the role of cognitive load as a potential influence on learning processes.

In addition, the role of prior knowledge (i.e., the factual and procedural knowledge within a certain domain) is one of the strongest predictors for successful learning (Hattie, 2008). However, there are inconsistent results regarding the role of prior knowledge in supporting metacognition. Bannert (2004), for example, found that learners with low prior knowledge within a domain might have difficulties in successfully using prompts, which may also be due to the additional cognitive load. Kapa (2001), on the other hand, found that metacognitive support had a greater positive effect on students with low prior knowledge than on students with high prior knowledge. Additionally, research on problem solving has shown that experts use metacognitive strategies more frequently than novices do (Richey & Nokes-Malach, 2015). In other words, the use of metacognitive
strategies becomes more likely the greater the prior domain expertise. Against this backdrop, we further address the role of prior knowledge and assume that instructional metacognitive support might be helpful on the way to becoming a successful problem-solver, especially when solving cases. Thus, learners with no or little prior knowledge should derive greater benefits from metacognitive support by using prompts compared to experienced learners. This leads us to the assumption that the effect of prompting depends on learners’ prior knowledge: Learners with low prior knowledge should demonstrate significantly higher knowledge acquisition in the promoting condition compared to the non-promoting condition, while for learners with high prior knowledge, there should be no significant differences between the two conditions (Hypothesis 2).

Finally, it can be assumed that not only prior knowledge within a domain might have impact on subsequent learning processes, but also prior knowledge related to metacognitive strategies: A higher level of metacognitive strategy knowledge might promote the use of such strategies and thus contribute to higher learning achievement. Nevertheless, it can also be assumed that the application of such strategies is an automatism. Learners with knowledge about metacognitive strategies might be supported by metacognitive prompts that help them to activate and apply this knowledge in a problem-solving situation (Bannert et al., 2009; Bannert & Mengelkamp, 2013). Thus, we assume that, in the prompting condition, the common use of learning strategies should be a stronger predictor for knowledge acquisition compared to the non-promoting condition (Hypothesis 3).

METHOD

Sample and design
Participants were 40 volunteers (N = 27, university students, mainly psychology students; N = 13 nonacademic participants). The average age was 25.90 years (SD = 3.91); 30 participants were female and 10 were male. The study was conducted using a one-factorial pre-/post-test experimental research design. Participants were randomly assigned to one of the two conditions (with or without prompting) with 20 participants per cell.

Material
The learning environment designed for this study was a case-and problem-based learning scenario on attribution theory and learning. It was designed as a hypermedia learning environment that allowed learners to navigate freely through the content. The program started with the case of “Benno”, a high school student whose school performance significantly dropped after he moved with his mother into a new town. In addition to the written case description, three video files presenting three perspectives on the reason for Benno’s problems were accessible (perspective of Benno, his mother and his teacher). Each of these videos presented different explanations based on attribution theory (Weiner, 1994). Attribution theory presents a framework how humans explain events or actions in daily life and how determine causes for such events. Attribution theory tries to explain why humans do what they do. Following Weiner (1994) the most important factors affecting attributions are ability, effort, task difficulty, and luck. These attributions can be classified within three causal dimensions: Locus of control (internal vs. external), stability (stable vs. not stable), and controllability (controllable by a person or not controllable). Within the scenario here, different perspectives were presented. Each of them presented a different attribution of causes to Benno’s problems in school.

Learners had access to five different pages within the learning environment that presented the theoretical background of attribution theory. This material was taken out of textbook chapters and modified for screen presentation. Learners could navigate freely throughout the case presentation, the video presentations and the theoretical background pages (Figure 1). All written and spoken texts were presented in German.

Measures and instruments
Knowledge test
In order to assess participants’ knowledge acquisition a test was constructed consisting out of 16 items (Cronbach’s Alpha = .75) based upon the content of the learning environment. The test consisted out of fill-in-the-blank questions, open questions and multiple-choice questions (e.g. “Which different kinds of attribution can be distinguished?”). Every question in the pre-test had the option “I do not know the answer”. All questions addressed the learning objectives of the learning environment, i.e., all questions and possible answers were related to Attribution Theory. The knowledge test was administered as pre and post-test with the same questions each, maximum score was 16 points. To ensure objectivity of analysis, the evaluation of participants’ results of the knowledge test was performed by a researcher who followed a pre-defined sample application. Only if there was a match between the researcher and the sample application, an answer was rated as correct.

Common use of learning strategies
The LIST questionnaire for measuring learning strategies of students (Wild & Schiefele, 1994) was applied in order to assess students’ common use of learning strategies. Regarding the pur-
pose of our study, we used three subscales: cognitive strategies (31 items; α = .81; e.g. “I try to make connections between the contents of related domains or classes”), metacognitive strategies (11 items: α = .72; e.g. “I try to plan which content of a certain domain I do or don’t have to learn”), and resource-oriented learning strategies (28 items; α = .83; e.g. “I do literature research when my own notes are not sufficient”). The instrument uses a 5-point rating scale (1 = rarely; 5 = very often) where participants indicate how often they use the particular strategies. The LIST was applied in post-test only.

Cognitive Load

In the post-test a slightly adapted version of the NASA-TLX (Task Load Index; Hart & Staveland, 1988) was used. To measure participants’ cognitive load is of high interest here as it provides information about participants’ information processing. The NASA-TLX consists of five self-report items (i.e. task requirements, effort in understanding the content, expectation of success, effort in navigation, and stress) and is a well-established instrument. Participants could indicate their answers on a five-point rating scale (1 = completely agree; 5 = completely disagree; the scale had an original internal consistency of α = .70; after exclusion of two items assessing expectation of success, the scale had an internal consistency of α = .88).

Procedure

Participants were randomly assigned to one of the two conditions (with prompting / without prompting). After assignment, the pre-test was administered. Subsequently participants started with the learning environment presented on standard IBM compatible personal computers (Figure 1). Every participant got the instruction: “The learning environment presented at the computer has been designed to enhance your knowledge acquisition within the domain of attribution theory. Your objective is to learn as much as you can about this topic. This will be tested in a post-test.” In the prompting condition, participants were additionally informed about the nature of and use of metacognitive strategies. They got the additional advice to choose one of the presented strategies on the prompting screen that appeared after each page turn within the software. After choosing a strategy, they had to fill in the form on the prompting screen by adapting the chosen strategy to their current learning progress (Figure 2). There was no given time limit for working with the program but on average, participants in the standard condition needed about 30 minutes time and within the prompting condition participants needed about 45 minutes. When participants left the learning environment the post-test was administered.

RESULTS

For all data analyses, values of single items were aggregated to
their scale values. For the knowledge tests, all correct answers were counted with a value of “1” and a sum score has been computed for pre-test and post-test correspondingly. For all other scales, the mean value of single items has been computed. Tests for normal distribution revealed that all dependent variables are normally distributed.

The results for knowledge acquisition revealed an increase from pre- to post-test. This increase was statistically significant for all groups ($F(1, 38) = 163.58, p < 0.001; \eta^2 = .81$). However, a MANCOVA using the knowledge pre-test as a covariate, the condition as an independent variable, and the knowledge post-test as a dependent variable revealed no significant overall main effect ($F(2, 36) = 0.13, p = 0.88; \eta^2 = .007$). The single contrasts also confirmed no group differences with regard to knowledge acquisition ($F(1, 37) = 0.15, p = 0.70; \eta^2 = .004$) and cognitive load ($F(1, 37) = 0.08, p = 0.78; \eta^2 = .002$). The descriptive values indicate a slightly increased value with regard to the knowledge post-test in favor of the prompting condition as well as a smaller value with regard to the cognitive load (Table 1).

Prior knowledge as a covariate showed an overall effect ($F(2, 36) = 15.22, p < 0.001; \eta^2 = .46$). Prior knowledge had a significant impact on performance in the knowledge post-test ($F(1, 37) = 21.22, p < 0.001; \eta^2 = .36$) and on the cognitive load ($F(1, 37) = 6.64, p = 0.001; \eta^2 = .26$). Correlation analyses reveal a moderate correlation between prior knowledge and knowledge in the post-test ($r = .60; p < 0.001$), and a moderate correlation between prior knowledge and cognitive load ($r = .52; p < 0.001$).

These results primarily do not support the first hypothesis. The prompting itself did not really affect learning outcomes, at least not to a significant extent. In order to test Hypothesis 2, a median-split was performed, using the median (= 4.0) of the knowledge pre-test results. A 2x2-factorial ANOVA with prior knowledge (high vs. low) and prompting (with vs. without) as independent variables as well as knowledge post-test results as a dependent measure were computed. The results revealed a significant effect for prior knowledge ($F(1, 36) = 14.24, p = 0.001; \eta^2 = .28$) and no significant main effect for prompting ($F(1, 36) = 1.38, p = 0.249; \eta^2 = .04$). The interaction between both independent variables missed significance by a margin ($F(1, 36) = 3.46, p = 0.071; \eta^2 = .09$).

The descriptive data reveals that especially learners with low prior knowledge benefitted from prompting (Table 2), albeit the assumed interaction did not reach a significant level.

**Table 1.** Means (standard deviations in brackets) of dependent variables. Cognitive Load scores range from 1 (highest) to 5 (lowest) self-reported cognitive load.

<table>
<thead>
<tr>
<th></th>
<th>Without Prompting</th>
<th>With Prompting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge pre-test</td>
<td>3.90 (2.38)</td>
<td>3.75 (2.78)</td>
</tr>
<tr>
<td>Knowledge post-test</td>
<td>8.23 (2.73)</td>
<td>8.38 (1.91)</td>
</tr>
<tr>
<td>Cognitive load</td>
<td>2.65 (0.76)</td>
<td>2.56 (0.84)</td>
</tr>
</tbody>
</table>

**Figure 2.** Example of a metacognitive strategy prompt.
As the number of participants within the cells becomes very small, an additional single comparison for the effects of prompting using Mann-Whitney-U-Analysis and comparing knowledge post-test results within the group with low prior knowledge was conducted. The results reveal a significant one-sided effect (\( U = 19; p = 0.038 \); one-sided). The same analysis for the group with high prior knowledge did not reach significance (\( U = 48.5; p = 0.501 \)).

In order to test the third hypothesis, linear regression models were tested. To this end, we used the performance in the knowledge post-test as a dependent variable and prior knowledge as well as the skills in use of metacognitive strategies (i.e., self-reported prior use of meta-cognitive strategies) as assessed by means of the LIST questionnaire as predictors. A stepwise linear regression resulted in the prompting condition with both of these variables as significant predictors (prior knowledge: Standardized Beta = 0.40; \( p = 0.02 \); prior use of metacognitive strategies: Standardized Beta = -0.58; \( p = 0.002 \) \( R^2 = 0.57, F = 11.26; p < 0.001 \)).

The model for the condition without prompting was also significant \( (R^2 = 0.54, F = 20.79; p < 0.001) \), but only revealed prior knowledge (Standardized Beta = 0.73; \( p < 0.001 \)) but not prior use of meta-cognitive strategies (Standardized Beta = -0.15; \( p = 0.362 \)) as a significant predictor. Thus, the results confirm Hypothesis 3, suggesting that metacognitive strategies and prompting together can contribute to the application of subsequent learning strategies, which, in turn, contribute to enhanced knowledge acquisition.

**DISCUSSION**

This study examined the influence of metacognitive support and prior knowledge on knowledge acquisition within a hypermedia case-based learning environment. There is a huge body of evidence that metacognition is one central key to initiate, apply, monitor and reflect learning, especially in self-regulated learning (Eckhardt et al., 2013). There is also evidence, that the long-term training of metacognitive strategies is helpful to support learners (Koch, 2001; Miller & Geraci, 2011). While such direct training strategies are not always beneficial (Jing, 2006), the application of rather indirect approaches like the prompting of metacognitive strategies has been proven to support self-regulated learning, especially in hypermedia learning environments (Bannert, 2004, Bannert & Mengelkamp, 2013).

The aim of our study was to replicate these findings on the one hand and to take into account the effect of students’ cognitive load on knowledge acquisition on the other. In contrast to the findings of Bannert and colleagues, we could not replicate that metacognitive prompting has a direct impact on knowledge acquisition: Learners in the prompting condition did not demonstrate greater knowledge acquisition than learners in the non-prompting condition (Hypothesis 1). A basic difference in the treatment might be a possible explanation: In the studies by Bannert and colleagues learners had to navigate through a large hypermedia learning environment and prompting was applied during navigation and mainly also referred to this navigation. The learning environment used in this study was rather well-structured and navigation was rather clear and implied a linear course. Thus, the prompting was designed to solve/explain the problem presented within the case-based scenario. What is more, the prompts were not adapted to learners’ needs, so every participant in the prompting group received the same amount and type of prompting. We could therefore not guarantee that all prompts provided were actually needed by the participants.

As additionally assumed in the first hypothesis, we could not find any influence of students’ cognitive load on their learning outcome. Students’ self-reported cognitive load was in the medium range across all study conditions. We can only presume why there is no difference here. On the one hand, it can be seen as positive that the prompting did not demand further cognitive resources, but on the other hand, it might indicate that the students did not really use the prompts intensively. For further research, an intelligent tutoring system as used by Taub, Azevedo, Bouchet and Khosravifa (2014), for example, might be better suited for this case.

The design of the prompts as suggested by Nokes and colleagues (2011) is another important aspect in relation to the student’s prior knowledge, as different prompts stimulate different cognitive processes. The effectiveness of the prompting varies depending on student’s prior knowledge as well as on the nature of the task and the learning content. It might be possible that the learning environment itself was not complex enough to make the

**Table 2.** Means (standard deviations in brackets) of dependent variables with prior knowledge as predictors.

<table>
<thead>
<tr>
<th></th>
<th>Low Prior Knowledge</th>
<th>High Prior Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without Prompting</td>
<td>With Prompting</td>
</tr>
<tr>
<td>Knowledge post-test</td>
<td>5.86 (2.38)</td>
<td>7.81 (1.98)</td>
</tr>
<tr>
<td></td>
<td>N = 7</td>
<td>N = 11</td>
</tr>
<tr>
<td></td>
<td>Without Prompting</td>
<td>With Prompting</td>
</tr>
<tr>
<td>Knowledge post-test</td>
<td>9.50 (1.99)</td>
<td>9.06 (1.67)</td>
</tr>
<tr>
<td></td>
<td>N = 13</td>
<td>N = 9</td>
</tr>
</tbody>
</table>

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prompting sustainably effective in general or, at least, provide a surplus value.

However, the assumed interaction effect between prompting and prior knowledge in our study likewise failed to reach significance (Hypothesis 2). We assumed that learners with no or little prior knowledge should benefit from metacognitive prompts by providing them central strategies for coping with the information provided within the learning scenario. While the missing interaction effect did not provide evidence for this assumption, a closer non-parametric analysis indeed revealed that learners with low prior knowledge benefit from metacognitive support. Nevertheless, for those who already possessed some experience within the learning domain, the likelihood of performing better in the knowledge post-test was significantly higher but remained unaffected by metacognitive prompting.

While the low level of prior knowledge in general did not really contribute to ideal conditions for testing the assumed hypothesis, the prerequisites for testing the third hypothesis were given: We assumed that the prompting rather facilitates and activates those learners that already possess and apply metacognitive strategies (Hypothesis 3). Indeed, findings suggest such an aptitude-treatment-interaction revealing that in the prompting condition performance in knowledge post-test was significantly and positively influenced by the availability of metacognitive skills and prior knowledge. It is likely that the prompting was able to activate this knowledge and to apply it to the learning environment. In the condition without prompting the only significant predictor for performance in the knowledge post-test was prior knowledge. Thus, we assume that there was no stimulus and no need for participants to apply their metacognitive repertoire. In other words:

The prompting of metacognitive skills contributed to enhance knowledge acquisition among learners that already possessed corresponding skills. This is in accordance with prior research, showing that especially learners with knowledge about metacognitive strategies benefit from metacognitive support (Bannert et al., 2009; Bannert & Mengelkamp, 2013). However, the activation of these skills within the learning environment is crucial. These findings imply that it might be helpful to provide a solid repertoire in metacognitive abilities first (e.g. by means of training) and then, as a second step, provide scaffolding approaches like prompting.

While this assumption could be confirmed, limitations of this experimental design did not allow validating the interaction of expertise and metacognitive prompting. A subsequent quasi-experimental design with real experts and novices might be able to analyse possible interaction effects.

Another limitation derives from the research approach as chosen here: The short-time intervention here was able to provide first and basic insights how prior domain knowledge and metacognitive skills can interact in applied problem solving. Nevertheless, findings from this study only affect learners with rather low prior knowledge within the chosen domain. It might be worthwhile to investigate the interplay between metacognitive abilities and knowledge acquisition within a domain or a program on the long run in order to investigate how these variables change and interact during time.

In addition, process data (e.g. thinking aloud protocols) might be helpful to analyse basic mechanisms of metacognitive support during applied problem solving. These might help to understand the way students navigate through the learning program, and with this information we might be able to identify critical moments in the learning program where students need support, which might in turn allow us to prepare the right prompts for this situation in further studies.

Finally, these findings might contribute to further design of problem solving course formats or PBL: Outcomes of this study suggest that novice learners can benefit from fostering metacognitive processes by means of scaffolding. This approach can be effective when such self-regulated learning skills are available but cannot successfully be activated or applied. Thus, it seems to be crucial to provide opportunities to develop and apply these skills by means of instructional support or devices. Especially at the beginning of courses or programs that require self-regulated learning skills such support might improve students' problem-solving abilities. With increasing expertise within a certain domain and increasing metacognitive abilities, such additional instructional support might become more and more unnecessary and can be faded out.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

FUNDING

None.

DATA AVAILABILITY

Not applicable.
AUTHORS’ CONTRIBUTIONS

JZ designed the study and wrote most parts of the manuscript, CO conducted the study and contributed to the research design; ID was involved in data analyses and also wrote some minor parts of the manuscript. SM also conducted data analyses and wrote some parts. All authors read and approved the final manuscript.

REFERENCES


Study of the Practical Application of Problem-Based Learning to a Major Class of Dental Hygienics: Focused on the Clinical Dental Hygienics Subject

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Purpose: To i) use outcomes of professional development on PBL for curriculum renewal that leads to more active student learning ii) use academic and clinical peers to develop a learning package that integrates education and practice of Clinical Dental Hygienics and iii) present and evaluate the authentic cases used as stimulus material that is learner-centered.

Methods: Professors of Dental Hygienics used professional development sessions to inform curriculum renewal and development of the stimulus material. Others with recent clinical experience used their expertise to assist with the development of learning packages. The PBL package was applied to two junior classes of Dental Hygienics and evaluated for perceptions of student satisfaction.

Results: The journey through PBL Package development and implementation, using peer support through Professional Development, is reported on. Responses to statements from a survey on learning experience indicated there was a high level of student satisfaction with learning; after the application of PBL (91.4%) responded positively to the statement, "I actively attended this class".

Conclusions: It is necessary to develop more packages that reflect the field of Dental Hygienics and extend the use of PBL to verify its effect. Additional evaluation of the use PBL packages needs to focus on learning outcomes that demonstrate links to actual practice and students’ problem-solving, self-directed learning, and team-work abilities that can be cultivated through PBL methods.

Keywords: Professional development; Problem-Based Learning; Clinical Dental Hygienics; Learning outcomes

INTRODUCTION

Recently, demands for a new image of man within society also led to calls for change in approaches to education (Hangyo, 2006). Increases in available information and access to knowledge are evident in our society. While schools are often the primary sources of information, it has become more and more impossible to apply and utilize that information in actual life (Hwang, 2002). In modern times, it is meaningless to make knowledge acquisition and simple memorization of details as the main objectives of education. The central ability in future society should be to utilize the acquired knowledge effectively. Creation of new knowledge will arise from enquiry processes and, education should aim to develop this ability (Yoon, 2009).

The purpose of contemporary education is to encourage self-directed learners with prob-
lem-solving ability. It is necessary to create a learning environment that allows learners with intrinsic motivation to apply related knowledge in the learning process (Kim & Kim, 2009). The abilities required in future society, besides the acquisition of basic knowledge, are problem-solving, creativity, information utilization, communication, team-work, and self-direction in learning (Kim et al., 2006). It is necessary to seek a learning method where students can learn about and acquire these various abilities effectively.

From survey feedback on the need for the development of an integrated curriculum for Dental Hygienics and Clinic-related subjects (Lim et al., 2016), a standardized curriculum was seen as necessary regardless of whether it was a three and four-year program. Integrating all clinical subjects in a role-centered curriculum was seen as necessary to produce dental hygienists with the expertise to cope with various actual situations from the clinical field. Bae, Shin, Jang, Chung & Shin, (2014) evaluation found that it would be necessary to integrate academic subjects like Basic Dental Hygienics with Clinical Dental Hygienics. The objectives and content would overlap and assessment of outcomes include the same competency statements for both. To ensure students’ knowledge expansion, application of knowledge to practice, and development of problem-solving ability, it is necessary to combine education methods, such as seminars, placements, team-based education, Case-Based Learning (CBL) and PBL. It is also necessary to develop a method for evaluating the actual competencies comprehensively. To realize the competence necessary for the clinical field, Dental Hygienics subject designers proposed the introduction of PBL as a central philosophy and method because it could involve all elements listed above. The designers aimed for more integration across subjects; they wanted to enhance the students’ problem-solving ability by using mutually agreed connections between theories and practical situations in the college curriculum (Bae, Shin, Jang, Chung & Shin, (2014); Kim, Kim, Oh & Nancy, 2009; Kim, Jang & Oh, 2009; Jeong, 2003).

In order to meet objectives and ensure competent performance of various tasks required of new dental hygienists, a move to competency-based models and a break from knowledge-centered learning was necessary. Competencies are behaviors reflecting vocational values, including integrated and comprehensive problem recognition and problem-solving ability. Instead of seeing ‘the performance of skill’ in a narrow sense, it would now include the knowledge and skill for performing the dental hygienists’ role (Jeong, 2009). For this, it was necessary to renew the curriculum to enhance the learning situations to focus more on student-centered problem-solving within an integrated education.

Given the discussion above, it was decided that a renewal project would include development of a learning package consistent with the principles underpinning integrated education and practice of Clinical Dental Hygienics. Cases as stimulus material would enable the use of creative teaching methods so that learners are the center of the progress of learning about the roles and functions of Clinical Dental Hygienists.

**Research Questions**

The renewal project was underpinned by a number of questions that demanded answers:

How would the curriculum designers develop a learning package that reflected integrated concepts relevant to Clinical Dental Hygienics? How do curriculum implementers ensure that learners are the center of the processes of learning about the practice of Clinical Dental Hygienics? How will educators discover problems reflecting typical situations that may occur in clinics but also demand solutions to problems? How can the design of stimulus material for learning reflect both the clinical field and education for the competency necessary in clinics?

Processes of reflection on the methods applied to curriculum renewal project are described. The results of the redesign initiative are then provided along with the feedback from the survey on student perceptions of their learning experience.

**Study Limitations**

Since this study did not include verification of clinical competency within package development, it was not possible to evaluate the learners’ problem-solving ability in the actual situations. There are insufficient preceding studies of PBL package development or examples of integrated education of Clinical Dental Hygienics; opportunity for comparison of outcomes is minimal.

**METHODS**

The research plan involved an iterative and collaborative curriculum renewal journey and the use of a survey on student satisfaction with learning processes and outcomes. To begin, the authors undertook some professional development, assuming the role of learners. They developed the Learning Package using consultation with PBL experts. They engaged in various PBL-related training courses such as PBL Learning Package Development and Tutor Skill Development (Halla/Newcastle PBL Center, 2019).

Professors of Dental Hygienics and Dental Hygienists with a clinical career of over five years collected examples of actual clinical situations. They aimed to integrate core concepts within two
theoretical and practically oriented subjects. Two junior classes of students in Dental Hygienics were to use the PBL package. Summative evaluation using a survey would determine students’ levels of satisfaction with the learning stimuli and check perceptions of the effect of the learning package.

**Research Approval and Ethical Considerations**

The student participants in this study listened to explanations about project content, including the necessity, purpose, method, anonymity guarantees for participation in research, the voluntary nature of participation in the project, potential for agreement and rejection, and possible advantages and disadvantages of the PBL method. When we formally applied to use PBL, students had agreed to participate. Approval for the study was from the Dong-Eui University Institutional Review Board (IRB Approval No: DIRB-201902-HR-E-02).

**Design of Subjects as PBL Units of Study**

The ‘major’ Clinical Dental Hygienics, was selected for introductory use of PBL methods. This is a subject in which the students first learn about integrated concepts and content presented, to build up to the detailed ‘major’ of Dental Hygienics. Early building blocks include completion of basic prerequisite subjects offered to freshmen and sophomores. This subject presents the standard ‘core’ competencies and other competencies, e.g. for health promotion, disease prevention, and the application of Dental Hygienics management, to allow the students to accomplish expertise and quality outcomes as dental hygienists necessary in clinics (Choi et al., 2017). Thus, the Clinical Dental Hygienics units of study should involve processes that cause the students to comprehensively think and make judgments using the concepts explored in prerequisite subjects. The designers concluded it would be effective to apply PBL methods to this subject. There was a need to develop and apply actual cases in clinics as stimulus material in a PBL package.

**PBL Package Development**

Having seen the need for a PBL method, bibliographical searches around PBL package development applicable to Clinical Dental Hygienics took place from November 2018 through January 2019. The researcher constructed a preliminary package. By participating in sessions on ‘PBL Tutor Skills’ and the ‘PBL learning textbook,’ and acting on expert advice (Halla/Newcastle PBL Center, 2019) the package development was completed in February 2019. Table 1 outlines the research procedures.

**Table 1. Research procedure**

<table>
<thead>
<tr>
<th>Research procedure</th>
<th>Research content</th>
<th>Research method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>Problem-Based learning related training : Total 3 times, attended related workshops (2018-2019)</td>
<td>Literature research</td>
</tr>
<tr>
<td></td>
<td>Collect package situations related to the subject : Expert advice</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select the person to apply</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collection of literature related to Problem-Based Learning(medicine, dentistry, nursing, pedagogy, clinical hygiene, etc.), expert interview</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selection of measurement tools through literature research</td>
<td></td>
</tr>
<tr>
<td>Development</td>
<td>Develop a package that includes the clinical situation</td>
<td>Literature research</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Multi-faceted evaluation of package composition and application</td>
<td>Package development</td>
</tr>
<tr>
<td></td>
<td>- PBL Expert Assessment</td>
<td>Expert evaluation</td>
</tr>
<tr>
<td></td>
<td>- Clinical expert evaluation</td>
<td></td>
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</table>

**RESULTS**

**PBL Package Development**

Bibliographical research on how to develop a PBL package for a Clinical Dental Hygienics subject provided evidence of the approach. The researcher then enrolled in ‘PBL Tutor Skill Development’ and ‘PBL Learning Textbook Development’ (Halla/Newcastle PBL Center). Mentorship and expert advice helped with Package development completed in February 2019.

**Package Application: Processes involved in the PBL Package**
for Clinical Dental Hygienics were: Determining the overall concepts, objectives and content, selection of learning tasks, clinical scenarios and choice of references, setting the outcomes of learning and composing scenarios, drawing up supplementary materials and preparing teaching guidelines, evaluating the validity of the learning package, and modifying and supplementing the original ideas. The five steps in PBL processes used were those proposed by Barrows (1998). These included class development, problem presentation, subsequent steps in problem-solving, suggestions for results and presentation, conclusions and solution to the problems. An algorithm was used for the effective utilization of time during the learning process.

The learners, working in groups, checked problems and discussed solutions, collected information, presented and shared the information. They acquired the knowledge, skill, and aptitude for problem-solving and evaluated problem-solving and learning results according to each step. The Professor presented the objectives of learning, facilitated discussions and summarized the learners’ ongoing work, asking them to supplement any perceived deficits. The learners had two laptop computers in each team so that they could explore problem-solving methods during the class; reference materials were also available in the classroom. One PBL package operated weekly (4 hours); the class used six packages over 15 weeks. Figure 1 shows the operationalization of PBL steps.

Selection of Situations: Capacity to reflect concepts that inform learning topics is critical. Contemporary situations frequently faced in practice should be reflected as learning stimuli and be appropriate for the learners’ level. Examination of existing subject content (across years) occurred in advance of PBL design processes. A profile of concepts and content from the freshmen year through the second semester of the sophomore year included Clinical Dentistry 1, 2, and 3, Preclinical Phase, Periodontics, Dental Health Pedagogy and Practice, Clinical Dental Hygienics and Practice 1 and 3, Dental Cleaning-related subjects, Clinical Dental Hygienics and Practice 2 and 4 (Preventive Dentistry and Preventive Dentistry Practice). Based on these details, the necessary scenario composition reflecting actual practice (content and level) was evident. For example, the topic dental caries, included pathophysiology concepts, other theoretical knowledge, treatment methods, and dental health educator’s activities as well. The situations to be explored should mirror those in clinics. The following were elements of preparation (from Objectives to Selection of Scenarios and Situations as stimuli for learning) that warranted careful consideration.

Learning Objectives: This refers to a description of the outcomes for learners as a result of completing the unit (HRD Korea, 2010). Usually, objectives for learning are outcome statements. However, here, importance was attached to objectives that reflect both processes and outcomes from the PBL experience. Objectives may limit the width of the learners’ thinking and exploration if they are too concrete. It is desirable to describe them comprehensively but focus on concepts. The objectives of the learning process need to be consistent with the learning method informing the development of the Learning Package (Lee & Park, 2001).

Timetable: The main subject concepts are classified, the objectives of learning set, a plan set for the week and semester in which PBL classes occur and the method and place of learning chosen. Package topics for each week were available to teachers’ timetables; details of Package use recorded semester and term of application and the number of the Packages. Timelines for Packages were available to learners.

Composition of Scenario: A scenario should include an unsolved problem and be appropriate for presenting various hypotheses. Also, it should be composed so that it causes in-depth thinking and exploration by the learners through the scenario cues. The topic of the scenario should effectively integrate ideas from various clinical fields. It should involve a problem that leads to a possible solution in the given class hour, and objectives, content, and difficulties of learning appropriate for the learners should be considered. Stimuli for exploration of ‘problems’ occurs in various ways - use of notices, questionnaires, news articles, fairy tales, pictures (photos), diaries, letters, conversations, cartoons, videos, standardized (simulated) patients, patients’ medical histories, and results of diagnostic checks. This scenario presented data progressively, dividing it into Parts 1, 2, and 3 using unstructured problems so that the issues and information could be ‘discovered’ by students.

In Part 1, understanding the ‘cues’ to the exploration of the social and environmental conditions within the text was necessary. For example, “Sitting in the waiting room, he is immersed in playing a mobile game”; or another part where the dental hygienist did not respond to the pain, and where the mother said, “My son is afraid of dentist’s office” and “He tends to skip meals and likes to have snacks”. If the cues are recognized, the problem situations and the inferences lead to further exploration. The process of identification of issues involves cooperative learning within the group.

In Part 2, where the patient responded, “I don’t know” to the dental hygienist’s question, “Was there anything you felt was uncomfortable?” and in response to the text, “Tell your mom”, it suggest a need to understand the role of behavior therapy in Dental Hygienics. The students need to find the relevant information but when the dentist uses terminologies such as ‘inlay’ and ‘resin filling’ in explanations, Hygienists need to use terms.
Stage 1: Class development

Professor’s class preparation
- Package development (Scenario, instruction manual)
- Creation a class atmosphere
  - Introducing Problem-Based Learning
  - Introducing the Role of Professionals and students
  - Small group configuration

Stage 2: Presenting the problem

Problem presentation confirmation
- Raise a problem → learners face a problem

Stage 4: Present and present the results

Total Learning-Presentation
- Announce group problem solving results

Stage 5: Conclusion and resolution

Summary and evaluation
- Write a reflection journal
- Submit individual assignments and group assignments
- Next time notice

Figure 1. Problem-Based Learning Application Stage.

appropriate for the client. They also need to find useful information, for example, on medical ethics for overtreatment in response to the “mandibular full mouth photo,” or when looking at the treatment plan in charts available. If relevant information is found, the problematic situations are understood, and solutions found through collaboration with peers in the group.

In Part 3, the Package begins and ends based on details learned from Parts 1 and 2. It finishes by revisiting the actual roles of the dental hygienist and the learning from the entire Package.

Selection of Situations: Capacity to reflect concepts that inform learning topics was critical. Contemporary situations frequently faced in practice were reflected as learning stimuli and
were appropriate for the learners’ level. Examination of existing subject content (across years) occurred in advance of PBL design processes. A profile of content and levels was evident. Topics reflected integration, for example dental caries, included pathophysiology concepts, other theoretical knowledge, treatment methods, and dental health educator’s activities as well. The situations mirrored those in clinics.

The following are reflections on elements of our PBL development journey.

Learning Objectives: Here importance was attached to objectives that reflect both processes and outcomes from the PBL experience; the learners’ thinking and enquiry processes led to active exploration of concepts. Objectives of learning were set by part, adjusting for difficulty.

Timetable: The main subject concepts were classified, objectives set, and plan set for the week and semester chosen. Package topics for each week were available for teachers’ timetables; details of Package use recorded semester and term of application and the number of the Packages. Timelines for Package were available to learners.

Composition of Scenario: Unsolved problems presented various hypotheses that led to in-depth thinking and exploration of ideas within the group. Effective integration of various clinical fields occurred. Exploration of ‘problems’ occurred in various ways across Parts 1, 2, and 3. The processes of identification involved cooperative learning. Relevant information was found, the problematic situations understood, and solutions found through cooperative learning.

Problem-solving approach: Situations were analyzed in connection to the objective of learning. A ‘guide’ helped arouse the learners’ interest for voluntary participation, developing hypotheses and analyzing problems. This package allowed the simultaneous roles of stimulation and guidance for the achievement of the objective of learning in each part, allowed for various thoughts to be aired around the primary problem-solving approach and analysis and classification of information and the expected cultivation of the learners’ problem-solving ability.

Tutor Guide: An effort was made to present a detailed Tutor Guide so that another tutor could also follow the discussion and overall operational plan for the introduction of the scenario, and the arrangement and method for group discussion and presentation time. However this was organized from the perspective of the learner, allowing for feedback so that students did not deviate from the topic for discussion.

Learners’ expected responses: The expected student responses were drawn up in advance with consideration of their need to move to higher level outcomes and a need for consistency with the problem-solving approach (Jeong et al., 2006). Expected responses were drawn up, taking various aspects into account and included in guidelines on PBL processes developed for facilitators.

Evaluation Plan: The purpose of evaluation or assessment in PBL is to induce students to engage actively with learning processes. Another aim is to induce comprehensive integration and application of knowledge, development of skills and attitudes. Learners evaluate the process of learning as well as the results of learning. These assessment tasks are composed by the teacher, using evaluation guidelines. Existing evaluation was mostly ‘academic’ testing knowledge acquisition. However, evaluation in PBL methods is more comprehensive and reliant on various forms and methods. The learner’s self-evaluation was de-identified and not recorded. PBL offers a chance for the learners to diagnose learning themselves, and for a tutor to prepare supplementary lectures to produce results like those in ‘usual’ evaluation. As a result, it can weigh up the learners’ academic accomplishments. Evaluation between team members and between teams can have a positive impact through the facilitation of discussion and learning. Another step involves modifying the Package as a result of learners’ evaluations of the Professor or the Package itself. The researcher recognized the value of PBL in subjects where the Package was applied; evaluation was positive and offered a chance to explore use with the ‘major’ subject Dental Hygienics. The final evaluation involved inter-group, peer, task and presentation evaluations.

Satisfaction with learning after completion of the PBL Package:

The evaluation tool, a survey on satisfaction with learning processes, was selected. The tool was modified by the researcher, referring to Park’s (2004) research tool for satisfaction with learning. The validity of the questionnaire was reviewed by two curriculum developers, and amendments to the tool completed. This questionnaire consisted of 15 questions about interest in learning, understanding in the problem-solving process, and satisfaction with the teacher variables. As a result of a survey on reliability and the application to the research subjects, Cronbach’s α coefficient was .85.

Table 2 shows details on ‘Satisfaction with learning after PBL’ (Kwon, 2010). Frequency analysis of the subjects’ (n = 35) satisfaction with PBL, most (91.4%) responded, “I actively attended this class,” and 77.1% responded positively - “I think I can utilize the content I learned in the practical class of Clinical Dental Hygienics in my actual life”; 62.9% responded, “I think my knowledge about Clinical Dental Hygienics-related subjects improved
through this class” and “I was free to ask the teacher questions and respond to them during the class.” None of them (0%) responded, “I do not think I can utilize the contents I learned in the practical class of Clinical Dental Hygienics in my actual life.” A few (2.9%) responded negatively, saying “I did not attend this class actively,” “I couldn’t clearly understand what I would know through this class,” and “I didn’t find the PBL problem-solving process pleasant overall”.

**Satisfaction with learning after applying the developed package for PBL**

As for the evaluation tool with which a survey on satisfaction with learning was conducted, the tool was reconstructed by the researcher, referring to Park’s (2004) research tool for satisfaction with learning. The validity of the questionnaire was reviewed by two curriculum majors, and the questionnaire was completed by modification and supplementation based on this. This questionnaire consists of 15 questions about interest in learning, understanding in the problem-solving process, and satisfaction with the teacher variables. As a result of a survey on reliability and the application to the research subjects, Cronbach’s α coefficient was .85.

Satisfaction with learning after PBL (Kwon, 2010) is like Table 2. As a result of a frequency analysis of the subjects’ satisfaction after PBL-centered learning, most of them (91.4%) responded positively to the statement “I actively attended this class”; 77.1%, “I think I can utilize the contents I learned in the practical class of Clinical Dental Hygienics in my actual life”; 62.9% acknowledging, “I think my knowledge about Clinical Dental Hygienics-related subjects improved through this class” and “I was free to ask the teacher questions and respond to them during the class.” None supported the statement “I don’t think I can utilize the contents I learned in the practical class of Clinical Dental Hygienics in my actual life” but 2.9% supported the statements “I did not attend this class actively”, “I couldn’t clearly understand what I would know through this class,” and “I didn’t find the PBL problem-solving process pleasant overall”.

**DISCUSSION**

This study reported on the processes involved in the development, evaluation, modification, and application of a PBL package for practical application to the Dental Hygienics major classes using PBL and evaluated students’ satisfaction with learning. The results have a limitation in generalization given the focus on application of PBL methods to one Clinical Dental Hygienics subject. However, the curriculum designers concluded that it will be possible to develop other packages for other Clinical Dental Hygienics subjects. As a result of this study, the following suggestions are made.

First, based on this experience, it was judged as necessary to develop various packages for each field of Dental Hygienics that could enhance learners’ satisfaction with programs. It is expected that the students would learn from professional placements in clinics and enhance their problem-solving and critical thinking abilities. Enhanced ‘sociality’ could also be achieved through better integrated clinical experiences. The provision of learning
Hye-Young Park et al. ▪ Focused on the Clinical Dental Hygienic

Package Part 1

1) Scenario For Part 1
(Feb. 10, 2018 09:30 am)

You are a dental hygienist working at the front desk of a dental clinic. Today is the first day of your shift at the front desk of the dental clinic. You are in the middle of examining the list of appointments.

Mother: I came because my son has a toothache.
You: Hi! Is that so? Have you ever been to our dental clinic before?
Mother: No, this is our first time here.
You: Oh, I see. Will you wait for a minute?

We'll check his teeth in the dentist's office in a short while.

(Imaginary Photograph)

You: It must hurt a lot. Did you just endure the pain until it became this condition?
Jae-hong: (sighs)
Mother: (sighing) My son is scared of coming to the dentist.
You: Is that so?

Mother: And he also tends to skip meals and eat candies.
Sigh... He doesn't brush his teeth often either.

Honestly, it was hard to even bring him here today.

Package Part 2

1) Scenario For Part 2

(March 26, 2018 10:50 am)

Jae-hong Kim has received 16 treatments since coming to the clinic. Today, he has an appointment for a gold crown attachment and treatment for other posterior oral cavities.

You: Jae-hong, was there any discomfort where your left-side molar was crowned?
Jae-hong: I'm not sure.
You: Oh... Is that so? Today we will be completely attaching the crown. As I explained last time, we need to treat the lower tooth with a cavity. Just wait for a minute... The dentist will explain it to you again.
Jae-hong: Just talk to my mother. About that... (10 minutes later Jae-hong's mother enters the dentist's office, and dentist Park inspects Jae-hong's mandibular cavities.)

Dentist Park: The cavities in his lower teeth are severe. So, inlays must be done on these two right-side molars. It looks like resin fillings can be done for these two left-side molars...

Mother: Isn't that expensive? How much will it cost?
Dentist Park: Our dental hygienist will explain it to you in detail, but it's in the range of about 400,000 won per tooth.
Mother: (Perturbed.) She silently looks at you.

Then, will the treatment begin immediately today?
(While the mother is in discussion, dentist park moves to another chair.)
You: Yes... Do you have any questions?
Figure 3. Evaluation table.
frameworks for students would allow them to apply these in novel situations that are not directly linked to a learning package.

Second, to confirm the effect of the application of the Package using PBL, it is suggested that it is necessary to increase the term of the application of PBL or develop a package in another field and verify its effects.

Third, for the development of the PBL package proposed in this study, the final draft was developed through peer support and expert advice (Clinical expert and PBL expert) was invaluable. However, it is necessary to evaluate if this Package can demonstrate learning outcomes such as the acquisition of expertise in Dental Hygienics and other outcomes that reflect problem-solving, self-direction in learning, collaboration in teams; these abilities can be cultivated through PBL.

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A Theoretical Need for Applying Flipped Learning to STEAM Education

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This paper addresses the current problems of STEAM education and suggests a solution to solve one of the problems through adopting a method from Flipped Learning. Through the meticulous literature review, comparison, and analysis on STEAM and Flipped Learning, it will be shown that the methodology of Flipped Learning complements the weaknesses in STEAM. The conclusion is that since there is a theoretical need for applying Flipped Learning to STEAM, further research needs to be carried out to apply flipped learning in STEAM classes.

Keywords: STEAM; Convergence; Flipped Learning; Educational methodology

INTRODUCTION

The goal of education used to be to train individuals to have certain skills and knowledge in order that they may have a higher chance of success in the future. Due to the rapid technological advancement in the last century and since the start of the new millennium, the future is more unpredictable. The goal of education now is to train individuals to be flexible and adaptable to the unpredictable future (Rychen & Salganik, 2003). In parallel with such a change, the need for pedagogical research has also increased (Evensen & Hmelo, 2000).

What is more important is that in the face of these changes, the limitations of existing teaching and learning methods are being revealed (Gilboy et al., 2015; Bazler & Sickle, 2017). The traditional teaching and learning method in the classroom is in need of improvement or changes. The manner in which the teacher communicates knowledge unilaterally to the students is less likely to make educational impact for the students who are already familiar with the culture of acquiring various pieces of knowledge from the internet and communicating with people in various communities online (Barrett, 2012; Herreid & Schiller, 2013; Roehl et al., 2013). The limitations and new demands in the field of education have advanced discussions on alternative paradigms of education (Hidi & Harackiewicz, 2000).

STEAM, which stands for Science, Technology, Engineering, Arts, and Mathematics, is a new educational system which hopes to prepare individuals for the unpredictable future. Originally based on STEM (which is without the Arts curriculum), STEAM aims to educate individuals to be able to think in a divergent and convergent manner (Bazler & Sickle, 2017). According to the results of research, STEAM appears to enable creative and critical thinking in humanities education (Ferrall, 2011). Therefore, it better educates individuals to live curiously and creatively with the knowledge on arts, science, and mathematics (Spector, 2015; Yakman & Lee, 2012).

However, STEAM has many problems too despite its advantages. It is true that the teachers who implemented STEAM recognize the importance of the integrated education method (Noh & Ahn, 2012). However, it has been pointed out that not only do the teachers need less work in implementing STEAM, but also the teachers do not seem to know the difference be-
between STEAM and the traditional science education (Park et al., 2016). Therefore, in order to solve these difficulties faced by teachers and to fulfill the purpose of STEAM successfully, it is necessary to expand the class time, to diversify the class space, to use various teaching materials in a communicative way, to secure communication space between teachers and learners, to provide individualized learning materials which take individual differences of learners into account (Lim, Kim, & Lee, 2014).

In order to solve the difficulties encountered by the teachers who want to continue to teach STEAM, such as the lack of time for the education, and the difficulty of knowing exactly how to proceed with the class, this paper suggests Flipped Learning as a methodology to complement STEAM. This review paper focuses on the need for learners and teachers to adopt the methodology of Flipped Learning in order to effectively achieve the goal of STEAM.

WHAT IS STEAM?

STEM, an educational system that the U.S. actively introduced since the late 20th century, aims to advance science and mathematics education as well as to focus on convergence between disciplines of science. Its goal is to enhance students’ interest in science, technology, engineering and mathematics as well as to advance technical literacy (Breiner et al., 2012). Traditional science education, which excludes the humanities, plays an excellent role in providing knowledge of mathematics and nature and skill in science and technology, but it was not effective in developing the creativity of scientists or to discover and solve interdisciplinary problems. (Madden et al., 2013). To overcome this problem, the movement to include humanities and arts in science-based education has been attempted by many scholars (Ghanbari, 2014).

STEAM was first introduced in the U.S. because the American Academy of Sciences realized that interest in STEM education was declining (National Academies, 2007). Yakman (2008), who first proposed the structure of STEAM, criticized STEM for lacking convergence even though STEM adopts an integrated approach to teaching and learning academic concepts in science, technology, engineering, and mathematics. She believed that STEAM was an optimal education system that can provide a wholly convergent structure of learning experience which cannot be achieved by the STEM only. According to Bazler and Sicklé (2017), STEAM education is currently an emerging educational model in the U.S., because it purports to overcome the weaknesses of STEM education.

The characteristic of STEAM is the introduction of the concept of convergence between basic subjects especially with the arts curriculum, which has not been actively pursued in the traditional curriculum. Convergence is one of the most important strategies for solving complex problems and solving complex intellectual problems in new fields in the 21st century. The students need to be prepared for the future by learning how to integrate ideas, approaches, and technologies from various knowledge fields (National Research Council, 2014). Therefore, STEAM aims to develop creative and future oriented talent by presenting a curriculum that can integrate individualized knowledge into one.

IMPORTANCE OF CONVERGENCE IN STEAM

The characteristics of convergence in STEAM can be summarized as follows. First, it is learning-oriented. Chopp (2014) suggests a conceptual concept of knowledge design that helps students learn about individual subject matter in a convergent way. Knowledge acquisition design aims to “grant creativity and clarity to the center of learning and learner attitudes” by accepting a new learning platform and recognizing the power of convergence of visualization power and knowledge (Chopp, 2014).

Second, it is dialectical. It gives emphasis on the process by which learners find and pioneer knowledge acquisition on their own. The process of searching for knowledge is only possible when the learners themselves ask questions from their curiosity about the knowledge and find an answer to the questions. The nature of this process is dialectical. As found in years past, teaching methods focused on teaching and learning in a dialectical way emphasized the importance of discussing and participating actively with other learners (Greeno, Collins & Resnick, 1996).

Third, various educational means are utilized. As found in past decades, in order to effectively integrate knowledge, it is necessary not only to teach using various media, but also to apply knowledge under various social contexts (Brown, Collins & Duguid, 1989). It is true that there have been many attempts to improve the effectiveness of learning using various media, not limited to textbooks in education (Mayer & Moreno, 2010). Attempts to actively utilize various media such as the internet, video, and mobile learning to construct convergent knowledge are characteristics of STEAM.

APPLICATION OF INSTRUCTIONAL DESIGN PRINCIPLES OF STEAM

The following instructional design principles summarize the re-conceptualization and restructuring of the curriculum in the
STEAM fields with various pedagogical teaching strategies in order to solve the needs and tasks of the 21st century. Palou et al. (2015) applied STEAM to construct a core support system for engineering students who would be prepared for the 21st century. They created a learner-centered learning environment and re-constructed the basic courses in chemistry and environmental engineering.

Coffland and Xie (2015) likewise describe the experience of teaching mathematics curriculum based on four skills required by the 21st century: Communication, Collaboration, Critical thinking, and Creativity (Partnership for 21st Century, 2011). Through this curriculum, they have enabled learners to face and experience the problems arising in real life in order to promote self-learning and to combine academic knowledge with real-life problems.

Christensen and Knezek (2015) adopted an active learning approach. The researchers proposed an attempt to actively include technology into the middle school science curriculum based on the STEAM skills required by the 21st century. Student-centered active learning has been shown to contribute to a long-term retention of knowledge and a deeper understanding of the subject (Akinoglu & Tandogan, 2007).

Furthermore, Aschbacher, Ing & Tsai (2013) suggest that if the content that students learn at school is more relevant to students personally and if the content is related to the future, the students’ become more drawn to the subject and learn more effectively and faster. Christensen & Knezek (2015) found out that with an active learning approach, students’ academic achievement increases and positively affects students’ attitudes toward science and related subjects.

Based on such studies, it can be concluded that STEAM is appropriate for preparing students for the future (D’Mello et al., 2014). In addition to this, with STEAM, students will be able to be more creative in the process of constructing knowledge in a convergent way. In addition, the STEAM focus introduces a way to acquire knowledge connectively through interaction and cooperation among learners, so that it is expected to increase the communication effect among learners.

SUGGESTED STEAM EDUCATIONAL STRATEGIES TO IMPROVE LEARNING

Ifenthaler et al. (2015) designed engineering education using a collaborative learning strategy. They suggest that the use of co-operative strategies has changed the attitudes of learners receiving engineering education, their thinking about themselves, and the activeness of a team. They published a case study that examined the effects of the learning organization model on attitude change, self-awareness, and organizational structure of student learning engineering (Mistree et al., 2014). This new curriculum emphasizes the capabilities and possibilities of individuals developed in a collaborative learning model and environment. In this model, learning took place at three levels: Individual learning, team-based learning, and group-based learning. Many of these curriculum strategies are designed to support STEM education, but they can also be applied to STEAM education.

Second, they suggest that, during the class teachers should organize students into small groups for in-class class activities or for activities outside of class. Unlike the traditional strategy of constructing the contents of the lesson centered on the topic decided by the teacher, the students can present the tasks, problems, questions, difficulties and contents contained in the topics to the students through one or more scenarios. Scenario-based approaches can be implemented under a variety of models, including problem-oriented strategies and project-driven strategies. Based on a scenario-based approach, students solve problems by presenting specific situations and scenarios in which problems are presented, and teachers are provided with tools to further develop the scenarios and the content. There is a lot of evidence to support the overall scenario-based approach, but there are a few drawbacks to the strategy of organizing students into small groups to increase classroom efficiency and performance. Teachers applying the scenario-based approach frequently have to organize students into small groups and test applicability of student led-group process to scenario-based strategies (Prince & Felder, 2006).

Based on these findings, Shen, Jiang & Liu (2015) proposed the following four STEM education strategies to improve students’ lifelong learning skills.

1. Designing activities to engage and motivate students in active learning: The essence of this strategy is to develop activities that help students take more responsibility for learning by creating student-led environment. These activities can be considered in various ways, such as demonstrating interesting scientific phenomena, writing science content related to a student’s personal life, extending learning to external learning areas, and linking science to other exciting academic disciplines or entertainment.

2. Using a scenario-based content: A scenario-based approach represents a broad educational strategy that provides learning materials to students over longer periods, centered on one or more scenarios. These cases can often be classified as problem-based, project-based, case-based, survey-based, or task-based.
3. Organizing Students Focused on Collaboration: This practice follows a strategy for organizing small groups and organizing learning communities. Collaborative work can stimulate interest in class by interacting face-to-face with students in various classes, before and after classes, or interacting virtually through the Internet.

4. Conduct research: This strategy is to encourage students to develop research that is of interest to them under the supervision of a teacher.

REPORTED PROBLEMS OF STEAM

Despite the advantages of STEAM, it has been reported that the teachers face a lot of difficulties when applying the STEAM in their classrooms. Lim, Kim & Lee, (2014) examined elementary school teachers’ opinions and experiences of teaching STEAM, and found that they think there is lack of STEAM activities and they face difficulties in preparation for STEAM classes. Although most teachers see the need for teaching STEAM classes, the lack of instructional materials discourage them from actively teaching STEAM. In addition, Lee, Park & Kim, (2013) report that there is shortage of classroom hours for teachers to effectively carry out the STEAM classes. For the integrated curriculum to be delivered requires teachers to have a lot of knowledge and plan student activities. It takes a lot of time to carry out a long-term project, but the current number of assigned teaching hours for STEAM is not enough for such activities. Shin & Han (2011) pointed out that there is difficulty for teachers to integrate educational elements and activities through STEAM when they conducted STEAM classes.

The potential difficulties that teachers face regarding STEAM are summarized in three points. First, there is a difficulty in lack of class time. STEAM not only requires a lot of knowledge and activities in the integrated subject matter to be delivered, but also demands a long enough classroom time to carry out the activities properly. Therefore, STEAM classes are not effective enough to achieve its original goal. Teachers may feel further burdened in overcoming the difficulties. Second, it is difficult for teachers to prepare class materials for STEAM. In fact, it is very difficult for the teachers to make the STEAM materials in accordance with the students’ interest and level. Third, students are not gaining enough knowledge that is supposed to be interdisciplinary and convergent. At the core of STEAM is to acquire interdisciplinary knowledge and to transfer such knowledge into produce more creativity. The activities conducted in STEAM are for acquiring convergent knowledge, but the problem is that learners are often more interested in the activities themselves rather than the interdisciplinary knowledge. These difficulties may be due to various reasons, but it is especially important to notice that there is a lack of communication channels to check whether learners really acquire interdisciplinary skills, and that the level of individual learners is not properly reflected in the actual classes either.

The current problems in STEAM, such as shortage of teachers’ time for preparing the STEAM classes and difficulties in coming up with classroom activities, can be complemented by introducing the methodology of Flipped Learning. Flipped Learning can be adopted to extend class time by providing opportunities to learn basic knowledge and concepts before STEAM class begins. In addition, the use of various high-tech media outside the classroom leads to the diversification of the classroom space. With the various teaching materials online, learners effectively absorb the knowledge according to their pace and preference. It enables individuals to change their learning speed according to their learning ability.

WHAT IS FLIPPED LEARNING?

Flipped learning is an alternative to the teacher-centered, traditional way of teaching. It emphasizes engaging activities among students and interactions between teachers and students (Ham-dan et al., 2013; Strayer, 2012). Traditional classes taught basic concepts and knowledge in the classroom and applied learner-centered activities as homework (McCarthy & Anderson, 2000). In contrast, Flipped Learning is a process of learning basic knowledge and concepts outside the classroom (Love et al., 2014). By “flipping” the classroom, students participate in various problem-solving activities based on learners’ interest and level of need in the classrooms, which is an innovative proposal for teaching methods (Bergmann & Sams, 2013).

In addition, Flipped Learning dramatically changes the content and aspects of classroom instruction (Bergmann & Sams, 2014). Flipped Learning allows students to voluntarily solve problems by cooperating with each other (Jamaludin & Osman, 2014). The role of the instructor is not exclusively limited to lecturing, but expanded to providing feedback and advice to students. Bergmann & Sams (2013) believe that the most important aspect in Flipped Learning is the meaningful learning activity that occurs in the face-to-face classrooms. Also, it is emphasized that the center of learning is not the teacher but the activities of the students and the students are taking into consideration the important activities to be done in the classroom. Strayer (2012) argues that the most important stage of Flipped Learning is the activity of expanding and deepening the concepts learned through video and various mediums in pre-classrooms in real classrooms.
In addition to the theoretical studies on Flipped Learning, the educational effects of Flipped Learning can be summarized in terms of improvement in learning ability among students (Saban, 2013). Flipped Learning improves self-directed learning ability, students' interest in learning, ability to understand the contents, problem-solving ability, and self-confidence. In addition, the aspects of cooperative learning, collaborative learning are emphasized by encouraging students to discuss problem-solving activities with each other, sharing knowledge among colleagues, and even teaching peers (O’Flaherty & Phillips, 2015).

To sum up, Flipped Learning, which has an educational effect on the cognitive dimension of students which broadens the level of knowledge and provides opportunities for mutual knowledge exchange among them, is becoming a popular educational approach to fostering talented individuals for the 21st century (Newman et al., 2016).

THE FOUR PILLARS OF FLIPPED LEARNING

Sams & Bergmann (2014), who have been leading the study of Flipped Learning, have established The Flipped Learning Network. According to the Flipping Learning Network Board, the characteristics of Flipped Learning are compared to the four pillars: Flexible environment, a Learning culture, Intentional content, and a Professional educator. The detailed characteristics are as follows.

First, Flipped Learning, which provides a flexible environment, accommodates a variety of learning methods. Teachers need to physically reconfigure the learning space for collaborative learning or individual learning in the process of optimizing the class. It is a feature of Flipped Learning to create a flexible space where learners can learn whenever and wherever they need. Furthermore, teachers who flip the classroom tend to be flexible in coping with learners’ learning plans and evaluations.

Second, Flipped Learning helps change the classroom climate into a learner-centered learning culture. In traditional teacher-centered instructional models, teachers had the authority to distribute information. In the Flipped Learning model, however, the lessons flexibly change with the learners. Such changes induce the learner to explore deeply on the subject and provide a rich learning experience. As a result, students engage in knowledge formation and evaluate their learning in a personally meaningful way.

Third, teachers who perform Flipped Learning continue to contemplate how to use the Flipped Learning model efficiently to help students understand the knowledge and the goal of education. Teachers can optimize class time to accommodate learner-centered, active-learning strategies, grade levels, and the curriculum.

Fourth, in Flipped Learning, teachers have professional knowledge of technology as well as being knowledgeable on the content. The role of the professional teacher in the Flipped Classroom is more important than the traditional classroom. During class time, teachers constantly observe students, provide them with instantaneous feedback, and assess their work. Teachers are reflective in the actual classrooms and engage in constructive criticism in relation to each other teachers to improve their teaching methodologies.

THEORETICAL ADVANTAGES OF COMBINING STEAM WITH FLIPPED LEARNING

Flipped Learning, which is being used as a new teaching method in the current education field, can be a useful method to implement the problems reported in STEAM. The first advantage is that Flipped Learning provides teachers with pre-learning materials and utilizes the cloud computing environment to enable easy learning through smartphones and tablet PCs regardless of where the students are and what time the students want to study. In addition, the pre-learning content itself provides information not only about the basic knowledge but also about how to practically implement the use of knowledge for students. This enables learner-centered education by helping students participate in real classroom activities more actively.

Park (2014) state the advantages of Flipped Learning as follows. First, students learn the concept of knowledge in advance and can concentrate on the STEAM activities in school classes. Second, teachers can efficiently utilize the STEAM program by applying the teaching strategies or class models suitable for the STEAM education through Flipped Learning.

Nowadays, Flipped Learning is introduced as a new learning system for this digital generation because students are already familiar with the use of digital devices, can multitask, and are capable of instant online communication. The most important aspect is the fact that it is student-centered. It is personalized learning. Student-centered classrooms use Dewey’s philosophy (Dewey, 1916) – the constructivist education paradigm as a philosophical basis for designing Flipped Learning (Ryder, 2006). In other words, Flipped Learning plays an effective role in establishing a student-centered classroom environment in which students select and construct content of their own. They become initiative as they become facilitators of knowledge, contrary to the tradi-
tional classroom teaching methods in which teachers are the center of the classroom.

Flipped Learning requires the teacher to constantly check and verify his or her class, because the teacher requires the student to rebuild the existing curriculum so that the students actively participate in the class. Through this process, the teacher prepares the lesson considering the interest, concern, and readiness of each student while considering the universal design for learning.

The advantages of adopting Flipped Learning into STEAM based on methodological characteristics are as follows. First, it allows teachers to balance the need to handle and deliver large volumes of learning content and the need for students to build meaning through interaction with the content (Bishop & Verleger, 2013). Second, because students actively use and apply knowledge in the classrooms, Flipped Learning can be seen by the teacher as a natural part of the students' overcoming weaknesses in the learning process (Butt, 2014). Third, Flipped Learning can increase student participation and motivation (Critz & Knight, 2013). Fourth, Flipped Learning can improve teacher-student and peer interaction (Gaughan, 2014).

The main advantage of Flipped Learning is that it can flexibly adapt to a variety of learning methods (Roehl, Reddy & Shannon, 2013; Schwartz, 2014). Unlike traditional classroom lectures, students are free to choose where and how to view the recorded lecture material before class (Forsey, Low & Glance, 2013). Teachers who have introduced Flipped Learning can no longer teach in class, so they can help them learn more effectively by developing higher-level learning methods and applying the practical skills (Stayer, 2012).

According to Hamdan et al. (2013), most Flipped Learning studies point out that students’ perceptions and learning effects through Flipped Learning were generally positive and preferred classroom activities with interactions rather than lectures. Bergmann & Sams (2013) also report that Flipped Learning has proven to be an effective learning method for children with diverse learning abilities and environments. Davies, Dean & Ball (2013) also show that classes that adopted Flipped Learning in college had higher academic achievement in those who did not. Flumerfelt & Green (2013) found that Flipped Learning has a positive effect on the academic achievement in high school.

In summary, using Flipped Learning, various kinds of advanced media are utilized, interaction between learners is encouraged, various learner-centered activities are performed, and communication between teachers and students is increased through such an interaction-based learning methodology. By actively utilizing these characteristics of Flipped Learning, the teachers of STEAM will be able to solve the problems that they faced: they will not have shortage of time teaching the basic knowledge and preparing the class materials and convergent knowledge of STEAM.

CONCLUSION

STEAM is aimed at fostering talented individuals who are able to creatively converge knowledge to creatively converge fragmented knowledge. However, due to lack of time for teachers and effective methodology, it failed to enable students to be creative and reconstruct the knowledge. One solution to this problem is to adopt the learner-centered methodology, Flipped Learning. It is a teaching method that can lead to integration of such knowledge. The educational model which combines STEAM with Flipped Learning motivates a need for providing instructional design to promote learners’ activity, responsibility, mutual understanding, and mutual trust among each other. Applying Flipped Learning for STEAM in the current education system, which requires students to be creative and flexible, will be able to not only positively change the interests and attitudes of learners, but also enhance creativity by creating a room for convergence of knowledge (Lewis, 2015).

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• Avoid citation of personal communications of unpublished material.

References

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• Books: Last name and initials of authors; year of publication; title of book (italicize); edition number (if after first edition); city and state of publication; publisher.


• Online References: Author(s); year of publication; title of the specific item cited (italicize); date the Web site was accessed; full URL


• Thesis


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1. All manuscripts submitted to Journal of Problem-Based Learning will be reviewed by at least two or three experts in the subject of the manuscript. All submitted manuscripts are subject to peer review on the basis of clarity, scientific accuracy, breadth of appeal, and timeliness. After the process of peer review, the manuscripts will be reviewed by editorial board members and then final decision for publication will be made by Editor-in-Chief of Editorial Committee.

2. Journal of Problem-Based Learning uses double-blinded review. The names of the reviewers will thus not be disclosed to the author submitting a paper and the name(s) of the author(s) will not be disclosed to the reviewers. The average time from manuscript submission to the author’s receipt of the editor’s decision about publication is approximately 3 months. Authors who are responsive to the suggestions of the reviewers are well placed to have their manuscripts accepted for publication.

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