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Tenth Issue of the Journal of Problem Based Learning in Higher Education

Bettina Dahl Søndergaard, Jette Egelund Holgaard, Thomas Ryberg and Patrik Kristoffer Kjærsdam Telléus *

INTRODUCTION

Dear Reader,

Welcome to the tenth issue of JPBLHE. Being the tenth issue marks a hallmark in the history of the journal. The journal is now consolidated, and we are proud of presenting this issue containing four research papers and five cases. Another hallmark is that we change editor-in-chief. Thomas Ryberg has been the editor-in-chief since the start of the journal and without his dedication, patience and insightful ability to set the course of the journal, we would not have been where we are today. We are sad to see him leave, but wish him all the best in his future endeavours. The editorial team wishes to thank him profoundly for all his hard work and for being such a great colleague. At the same time, we are thrilled to announce the new editor-in-chief, Patrik Kristoffer Kjærsdam Telléus. We have known Patrik for a long time, and feel completely confident to put the leadership of JPBLHE in his hands. We look forward to what the future will bring. The readers can read special greetings from the two editor-in-chiefs below.

THE FOUR PAPERS

Author country	Education programme	Topic
Denmark	Humanities	Learning analytics and Problem-based learning
Turkey	Computer education and instructional technology	Web 2.0 Technologies
Denmark	Urban Planning	Action research in planning education
United States of America	Professional studies	Experiential Problem-based learning

* Bettina Dahl Søndergaard, Department of Planning, Aalborg University, Denmark
Email: bdahls@plan.aau.dk
Jette Egelund Holgaard, Department of Planning, Aalborg University, Denmark
Email: jeh@plan.aau.dk
Thomas Ryberg, Department of Communication and Psychology, Aalborg University, Denmark
Email: ryberg@hum.aau.dk
Patrik K. Kjærsdam Telléus, Department of Health Science and Technology, Aalborg University, Denmark
Email: pkt@hst.aau.dk

The issue contains four research papers and each of them presents examples of research that marks new directions in the development of PBL. Two papers (Kilińska, & Ryberg; Ünal) aim to study the new digital directions of PBL. The other two papers (Frandsen, & Andersen; Minor-Romanoff, Rae, & Zakrzewski) relate to new directions of PBL to cope with the increasing complexity of problem solving processes.

The first paper is written by two authors from Aalborg, Denmark (Kilińska, & Ryberg). The purpose of the paper is to investigate how the relatively new field of Learning analytics (LA) can potentially be used to support and inform PBL practice. The authors combine PBL and LA by identifying central themes of PBL and present examples of LA tools and concepts in connection to those themes. The authors conclude that automation of feedback and assessment provides an opportunity for employing PBL at a larger scale, not only in small classrooms, while preserving the main principles. For readers who want to combine LA and PBL, the paper furthermore presents an interesting discussion of the possibilities, challenges and implications of doing so.

The second paper is written by an author from Afyonkarahisar, Turkey (Ünal). The purpose of this paper is to present general trends with regard to Web 2.0 technologies supporting PBL environments. The trends are analysed in a systematic literature review of studies combining Web 2.0 and PBL. The paper concludes that the effectiveness of Web 2.0 technologies supporting PBL was the most frequently reported finding in the literature, whereas Wiki was the most preferred Web 2.0 tool utilised within the PBL environments. However, the literature also reported on the effects of Web 2.0 technologies supporting PBL concerning participants' skills and achievements. Finally, the paper points to potential further research to increase the scope of using Web 2.0 technologies in PBL environments.

The third research paper is written by two other authors from Roskilde, Denmark (Frandsen, & Andersen). The paper presents a synthesis of two cases from urban planning where PBL is related to an action research approach for sustainable transition. The educational design follows a model adapted by one of the authors showing the prototypical phases in community-based action research. This action research approach to PBL is applied in two cases in the planning domain. The first case considers a renewal project of a neighbourhood and the second a sustainable street transition, both in Copenhagen. Even though the cases have differences, the authors conclude that in both cases, the perspective of letting the student do action research strengthen their ability to master practical and ethical judgements in complex real-life learning processes.

The fourth research paper is written by three authors from New York, USA (Minor-Romanoff, Rae, & Zakrzewski). The paper describes an experiential problem-based multifaceted instruction design and teaching model applied at the New York University School of Professional studies. The model combines traditional instructional design, evidence-based

strategies and learning theories for critical thinking and transferable skills. The model includes applications and theoretical combination for an ill-structured problem-solving design and teaching model for an entire programme. The perspective is to equip students with complex problem-solving skills to increase their capabilities in industry and other professional contexts. The paper furthermore presents findings to clarify the preconditions and perspectives for bringing the model into practice to inspire readers of JPBLHE to follow a comparable path.

THE FIVE CASES

Author country	Education programme	Topic
Sweden	Environmental science	Supporting student's self-directed learning in PBL
United States of America	Teacher education	Digital problem-based learning in science methods courses
Denmark	Communication and Digital Media	Lessons learned from an educational design experiment
Taiwan	Adult learners in vocational higher education	PBL for soft skills training
Argentina and Spain	Social Communication	PBL for teaching transmedia communication

This issue contains five cases. Although the cases are quite different in origin (country, student level), they are also quite connected. The three first cases (Johansson, & Svensson; Rillero, & Chen; & Davidsen, Andersen, & Christiansen) are focused around how students by themselves work in PBL and how the teachers can help them while maintaining the students' autonomous work. The two latter cases (Lee; & Bron, & Barrio) are focused on how PBL helps developing soft skills and life-long learning skills.

The first case is written by two authors from Karlstad and Linköping, Sweden (Johansson, & Svensson), and the focus is on how university students work between supervision meetings. Studies show that some students unfortunately do not spend enough time self-studying during this phase, wherefore Linköping University implemented a new instrument, an Individual reflection paper (IRP) to support the learning process between the supervision meetings. The paper shows how the students experienced working with IRP and how it influenced their learning process. Results show that a majority (90%) of the students found that IRP supported their work, particularly students in the beginning of their studies. They particularly found that the tool supported better discussions and gave all students the opportunity to show participation.

The second case is written by two authors from Arizona, USA (Rillero, & Chen), and the focus is on teacher education in PBL for K-12 (grades 1-12). The outset of the paper is that PBL implementation requires different teacher roles than teacher-centred instruction and the paper describes the use of a PBL module in a science methods course and how the preservice teachers

experienced the module. The students were English Language Learners, who face additional obstacles to learning than other students. The paper described that it is a particularly challenge to find the balance between support for students and the autonomous work of the students. The module is described and evaluated through both quantitative and qualitative methods, and findings showed that the teacher candidates generally had positive attitudes about the module.

The third case is written by three authors from Aalborg, Denmark (Davidsen, Andersen, & Christiansen), and the focus is on an experiment with university students to promote interaction and knowledge sharing in the groups. The paper focuses on a PBL course that introduces new students to the core principles of PBL. The experiment had the purpose of making the work of each of the groups publicly available to the entire semester class for inspiration and criticism. A PBL Box full of tangible materials was therefore introduced. One of the lessons learned was that educational designs are difficult to implement in practice if it is not mandatory for the students, teachers, and supervisors. The paper concluded by offering suggestions on how to improve the use of a PBL Box.

The fourth case is written by one author from Taipei, Taiwan (Lee), and the focus is on adult learners in vocational higher education. Students in Taiwan do not usually learn group learning skills in junior or senior high school education. The Taiwan Ministry of Education, therefore, initiated a programme aimed at encouraging the Institutions of Technology to adopt PBL for soft skills training. These skills are developed as part of a PBL course, and they are described and reflected upon in this paper. One issue raised in the paper is the importance of scaffolding strategies in PBL, especially for low achievers or PBL novices.

The fifth case is written by two authors from La Rioja, Argentina and Madrid, Spain, respectively (Bron, & Barrio), and the focus is on last year university students. Here, PBL was implemented in a course in Multimedia Communication as "learning to learn" to support the development of life-long learning skills which are essential to develop in an area that is constantly changing. The course involved that students should tell a story through the use of different media and the project evolved around how it was possible to make the life of a historical figure known in an innovative and creative way. One of the results reported was that students learned different techniques for working collaboratively.

GREETINGS FROM OUTGOING EDITOR-IN-CHIEF: THOMAS RYBERG

I have been editor-in-chief for the International Journal of Problem Based Learning in Higher Education (JPBLHE) since the inaugural issue in 2013. This has been a most rewarding, but also difficult task. Setting up a new interdisciplinary journal is academically rewarding and interesting. Discussing scope, aims and how the journal fits into the wider scholarly landscape

has been done in collaboration with the editorial board and the editorial team, and I am thankful to all the people in the boards for their engagement with the journal over the years. Also, although a trivial point, a journal cannot sustain without authors and readers, so I would like to thank all readers, but in particular the authors who with their paper, reviews and cases have contributed to shaping the journal, but moreso the scholarly landscape of Problem Based Learning. I am happy with what we have accomplished over the years, and I think for the journal to further develop and embrace new ideas, formats and networks it is important that new people come in and start shaping the journal. Therefore I am very happy that Patrik Kristoffer Kjærsdam Telléus has decided to pick up the role of editor-in-chief and I am looking forward to working with Patrik in the transition of editorship. I will of course remain a reader of and contributor to the journal.

GREETINGS FROM INCOMING EDITOR-IN-CHIEF: PATRIK KRISTOFFER KJÆRSDAM TELLÉUS

I am Patrik Kjærsdam Telléus and in January 2020, I start as editor-in-chief for the International Journal of Problem Based Learning in Higher Education. First, I would like to thank Thomas Ryberg for his wonderful work and his commitment to the journal. Under his wings' the journal has developed into a thorough and insightful journal honoring academic standards and research quality. It is a great honor to try to pick up from where Thomas has left off. I'm looking forward to work closely with the editorial team and the editorial board ensuring that our journal is continuously regarded as one of the most essential journals for PBL research, and that it remains attractive for a diversity of scholars and laymen interested in the field of higher education. It is a huge privilege to steer this journal into the coming decade, where meticulous academic effort and research integrity are virtues that we need to treasure and protect, to ensure that the knowledge and the guidance that our journal provide is a solid and meaningful counterpart to dogmatic or affected oversimplifications, quick-fixies and opinion-makers. A scholarly journal is an opportunity for researchers to fight ignorance and arrogance, not merely amongst themselves, but as tendencies in the society in which they take part. As Emerson put it: "The office of the scholar is to cheer, to raise, and to guide men by showing them facts amidst appearances." To this call, the journal and I will gladly commit.

THANKS TO REVIEWERS

Finally, we should like to thank all the reviewers who have contributed to the improvement of the papers and cases published in 2019:

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Connecting Learning Analytics and Problem-Based Learning – Potentials and Challenges

*Daria Kilińska and Thomas Ryberg**

ABSTRACT

Learning analytics (LA) are a young but fast-growing field, which, according to some authors, holds big promises for education. Some claim that LA solutions can help measure and support constructivist classrooms and 21st century skills, thus creating a potential of making an alignment between LA and PBL principles and practices. Despite this argument, LA have not yet gained much interest among the Problem-Based Learning (PBL) practitioners and researchers and the possible connections between PBL and LA have not yet been properly explored. The purpose of this paper is, therefore, to investigate how LA can potentially be used to support and inform PBL practice. We do this by identifying central themes that remain constant across various orchestrations of PBL (collaboration, self-directed learning, and reflection) and present examples of LA tools and concepts that have been developed within LA and neighbouring fields (e.g. CSCL) in connection to those themes. This selection of LA solutions is later used as a basis for discussing wider potentials, challenges and recommendations for making connections between PBL and LA.

Keywords: Problem-Based Learning; Learning Analytics; Collaboration; Self-directed learning; Reflection; Self-regulation.

INTRODUCTION

Learning analytics (LA) are a field that has gained increasing attention within the wider field of educational technology but is relatively less explored specifically in relation to Problem-Based Learning (PBL). LA advocates argue that the field holds great potential for improving and optimising education, with some of them claiming that LA solutions

* Daria Kilińska, Department of Communication and Psychology, Aalborg University
Email: daria.kilinska@gmail.com
Thomas Ryberg, Department of Communication and Psychology, Aalborg University
Email: ryberg@hum.aau.dk

can help measure and support constructivist classrooms (Blikstein & Worsley, 2016; Dietrichson, 2013) and 21st century skills (Shum & Crick, 2016). This, combined with the growing popularity of the field, makes it difficult not to consider the possibility of making a connection between LA and PBL, and start asking what LA can offer to PBL practitioners and vice versa. In this paper, we try to take a step back, look beyond the promises, and examine the field of LA to understand the potential and challenges it offers in relation to PBL by discussing both concrete tools and practices as well as recent conceptual developments.

We start with a brief presentation of the field of LA, its potential applications and reasons for its growth. Next, as PBL is a multifaceted pedagogy and field that covers a diversity of practices, theories, and models, we draw out some common and central themes (collaboration, self-directed learning and reflection) that cut across various orchestrations of PBL. We do so, as we do not want to limit our discussion to a particular implementation or model of PBL, such as the Maastricht 7-step approach, or the Aalborg PBL model. Although LA have not yet been much spoken of in connection to PBL, LA and neighbouring fields, such as CSCL, have already been looking into LA's potential in relation to some of the themes that are also of interest to the PBL community such as problem solving and collaboration (e.g. Fischer, 2015; Joksimović et al., 2016; Saqr, Fors, & Nouri, 2018). Thus, in this paper we aim to look at examples of how the central PBL themes that we identified have been addressed by the LA community and researchers from other fields, with or without a specific reference to PBL. We use the themes as a base for examining how various existing LA tools, practices, and approaches might hold interesting perspectives for PBL, but equally for reflecting on the shortcomings and challenges in relation to employing LA within the frame of PBL. We conclude the paper with a synthesising discussion and recommendations on the way forward, as the overarching purpose of the paper is to explore how LA can inform PBL and what the challenges and potentials are of employing LA to support PBL.

WHAT ARE LEARNING ANALYTICS?

LA are concerned with the "measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs" (Siemens, 2010). This field of research is relatively new, as it only just emerged in the last decade, but it has roots in more mature fields, such as business intelligence, web analytics, educational data mining and recommender systems (Ferguson, 2012). Its rise was fuelled by three driving forces (Ferguson, 2012): the challenge of extracting value from a growing body of educational data collected from

online environments, significant increase in the popularity of online learning with associated need to optimise the online learning opportunities, and, finally, the political demand to show and improve performance. The data that the LA tools use to achieve different educational goals is mainly gathered through monitoring students' online activity (e.g. access to resources, logins, textual input) (Rubel & Jones, 2016). This data collection is not really limited to specific sources, such as Learning Management Systems (LMSs), but encompasses various tools, techniques or environments (García & Benlloch-Dualde, 2016), e.g. forums, blogs, interactive whiteboards, social sites, libraries, or MOOCs.

Potential applications of LA in education

The proponents of LA argue for a wide range of potential uses, such as prediction, intervention, recommendation, personalisation, reflection or iteration and benchmarking, that are connected to challenges driving the fields' development (Khalil & Ebner, 2015). The prediction of students' future performance and activities allows for identification of at-risk students (Sclater, Webb, & Danson, 2017), applying early interventions and thus achieving different stakeholders' goals, such as an increase in retention (Almutairi, Sidiropoulos, & Karypis, 2017), and improvement of students' academic success (Khalil & Ebner, 2015). LA can be used as a tool to provide different types of recommendations to students regarding people, resources, activities (Duval, 2011), or choice of courses (Ferguson et al., 2016). They also have a potential of creating more personalised learning opportunities for students either by automatically adjusting the material to individual learners or by providing students with recommendations that they can use to shape their learning (Chatti, Dyckhoff, Schroeder, & Thüs, 2012). LA aim to provide both learners and teachers with data for reflection on their work that can lead to improvements in the learning process in the future (Khalil & Ebner, 2015). Another potential use of LA, benchmarking, can be seen as "a learning process, which identifies the best practices that produce superior results" (Khalil & Ebner, 2015, p. 131). In that sense, one of LA' goals, is finding the weak aspects of the learning processes and environments, and optimise them based on the knowledge of best practices.

The reasons for the continuous growth of the field

Even though the field of LA still faces many challenges, the promises and hopes associated with the application of LA are high, so it is not surprising that the field's popularity is increasing rapidly (Ferguson et al., 2016). Simon (2017) gives several reasons why LA will become more widespread in the near future. One of them is related to constant technological development, which ensures that the new LA tools become less dependent on data collected from online environments. Without data on students' interaction outside of the online systems, we are not able to paint a holistic picture of students' learning process (Mangaroska & Giannakos, 2018; Slade & Prinsloo, 2013).

One way in which the field has been trying to address this challenge is by putting more focus on multimodal learning analytics (MMLA), understood as "multimodal data collection and analysis techniques" (Blikstein, 2013, p. 102). Data for MMLA can be collected using not only logs of activities completed on a computer or mobile devices, but also by employing such technologies as biosensors, eye tracking, infrared imaging, or wearable cameras (Blikstein & Worsley, 2016). Such a wide range of data sources allows for use of various types of techniques that can give educators an opportunity to analyse speech, handwriting, sketches, gestures, affective states or eye gaze, which means that MMLA potentially makes it possible to analyse, measure and optimise learning happening in face-to-face settings.

Another rationale for explaining the growth of the field is associated with the economic pressure to automate education (Taylor, 2001) in order to increase the number of graduates, and improve performance while lowering the costs (Mehaffy, 2012). It is clear that there is a strong political interest in relation to how 'data' can inform and improve education (Williamson, 2017). Perhaps for that reason LA are often oriented towards individuals rather than groups or networks (Dohn, Sime, Cranmer, Ryberg, & de Laat, 2018; Fawns, 2018), and identifying at-risk students to provide them with early interventions remains the primary focus within the field (Ferguson et al., 2016). This trend is associated with LA solutions that are technology- rather than pedagogy-driven (Dohn et al., 2018), a shift that may bring worrisome consequences to education, with learners being sculpted not by pedagogic expertise, but rather by assumptions of technical experts (Williamson, 2016). While this overarching tendency needs to be acknowledged, it does not encompass the whole field of LA. There is a tension between the economic and institutional perspective concerned with dropout rates, and the more research-led trend that focuses on constructivist principles, 21st century skills, student autonomy and providing actionable feedback to improve learning rather than retention.

The increase in popularity of the field is then related also to the growing emphasis on developing students' 21st century skills (Dede, 2010). The new set of skills, including collaboration, independent thinking, problem-solving, and decision making (Silva, 2009), is needed for successful work life and citizenship, some argue (Dede, 2010). Those skills often cannot be sufficiently (or at all) measured by traditional assessment methods (Griffin & Care, 2015), with some researchers claiming that they cannot be measured at all (Silva, 2009). As the various learning-related interactions are now frequently mediated by ICT and thus create digital traces, educational researchers hope that LA will bring an opportunity for measuring and facilitating 21st century skills (Simon, 2017).

PROBLEM-BASED LEARNING

As initially stated, we do not take departure in a particular orchestration or model of PBL in this article. Rather, we aim to describe some broad and commonly shared principles that cut across various concrete implementations of PBL. Further, we do so, with the specific aim of identifying themes that have also emerged within the field of LA.

Broadly speaking, PBL is a pedagogical philosophy covering a multitude of practices and is applied differently whether implemented in K12 or Higher Education. Even within higher education, there are different PBL models, such as the Aalborg PBL model (Kolmos, Fink, & Krogh, 2004) and the Maastricht model (Graaff & Kolmos, 2003). In PBL-based models, learners usually have a high degree of autonomy and responsibility for their own and others learning, and PBL often encompasses elements of reflection, peer- and self-assessment (Graaff & Kolmos, 2003; Savery, 2006; Savin-Baden, 2007). Generally, various models of PBL feature group work or collaborative work, although the exact nature and extension of the collaborative work can differ (Ryberg, Koottatep, Pengchai, & Dirckinck-Holmfeld, 2006). Savery (2006) crystallises a number of PBL principles to the following three:

> 1) *the role of the tutor as a facilitator of learning, 2) the responsibilities of the learners to be self-directed and self-regulated in their learning, and 3) the essential elements in the design of ill-structured instructional problems as the driving force for inquiry.* (Savery, 2006, p. 15)

Savery (2006), it should be noted, equally stresses collaboration as an essential feature, although he does not mention it in the summary of the principles. However, the distribution of responsibility for the learning process clearly rests with the students, with the 'teacher' as a facilitator, and the notions of autonomy, self-directedness or self-regulation as central. Adding to this, the notion of ill-structured problems as the driving force for learning is a very central aspect of PBL, which however is difficult to find directly addressed in the literature of LA.

In this paper, we contribute to examining the issue of making an explicit connection between LA and PBL by picking out three central themes within PBL, that also align well with research within the field of LA, namely: collaboration, self-directed learning, and reflection, which are central PBL themes also highlighted by Camacho, Skov, Jonasen, & Ryberg (2018), and we investigate how these themes have been addressed by the field of LA and neighbouring fields.

LEARNING ANALYTICS TO SUPPORT PROBLEM-BASED LEARNING PRINCPLES – CONNECTING PBL AND LA

The field of LA is still in the process of establishing the connections to the learning theories and educational research, with many of the existing tools not naming the theory or paradigms of learning they are based on. Thus, it is not surprising that the number of LA applications that specify their relation to PBL, or any other learning approach, is still limited. As of now, there is no agreed upon existing set of LA tools that can successfully support PBL. The majority of the LA tools that are available in LMSs do not provide very diverse information on students' activities, focusing mainly on system logs and clicking behaviour (Dietrichson, 2013), and using only one platform for data collection. Mangaroska & Giannakos (2018, p. 12) argue that this limitation "hinders the holistic approach to understand the learning process as an ecosystem". The existing LA tools and plugins for LMS are seldom mentioned in LA literature in relation to supporting and analysing 21st century skills, and, with rare examples (Triantafyllou, Xylakis, Nilsson, & Timcenko, 2018; Triantafyllou, Xylakis, Zotou, Tambouris, & Tarabanis, 2018), are not really utilised by PBL practitioners. Despite these limitations, PBL practitioners may soon find themselves in a situation where using LA features is not a possibility, but a requirement. As the popularity of the field of LA is growing, with new LA tools being introduced into existing LMS and the institutional need of showing performance, there is a pressure to start introducing LA into the teaching practice at different levels of education. We therefore find it valuable to put more focus on the discussion of the possible connections between LA and PBL and to involve PBL practitioners in this discussion. We start by briefly describing two examples of LA research related specifically to PBL. This will be followed by examples of existing LA features that do not have an explicitly stated connection to PBL, but still investigat or support some of the main principles of PBL: collaboration, self-directed learning, and reflection (Camacho et al., 2018).

Hogaboam et al. (2016) conducted a study which aimed to investigate the use of LA tools to support instructors in facilitating an online PBL workshop for medical students. The facilitators in the study were given access to the students' part of the learning environment, including a video feed, discussion space, and a whiteboard section. Moreover, they could consult different visualisations that were made available for them in a LA dashboard, such as charts showing the students' textual output in relation to others, the textual output produced by the group as compared to other groups, and a progression bar representing task completion. The dashboard also included a scrollable news feed showing a list of the actions performed by the students, an interaction graph of the discussion, and a word cloud consisting of the most commonly used words. However, even though a variety of LA features were created to support facilitation, the actual use

of the LA dashboard turned out to be very limited, as the facilitators did not really know how to make sense of the visualisations. Instead, they based their facilitating actions on the output created by students.

The PBL workshop enriched with the LA dashboard analysed by Hogaboam et al. (2016) happened entirely online, which made the data collection significantly easier than if it took place in a face-to-face or hybrid setting. An example of a research that aimed to analyse data collected in a face-to-face context is the work of Spikol, Ruffaldi, & Cukurova (2017), who attempted to analyse which of several multimodal features could be considered good predictors for collaborative problem solving (CPS), a process common within Problem-Based and Project-Based Learning. The engineering students worked in groups, using furniture supplemented with MMLA system capable of tracking the position of faces, hands and other objects, and a platform capturing interaction information. Spikol et al. (2017) coded video-recordings of the group work, to later compute scores on different indicators of successful collaborative learning, such as physical engagement or synchronisation. They managed to show that the direction of students' gaze, the distance between them, and hand motions are regressors of the above indicators, and could be used to identify collaboration. The authors argue that those results show that MMLA could support an assessment of CPS within Project-Based Learning and provide insights into the processes involved in face-to-face learning.

Collaboration

One of the recent proposals focusing on collaboration was made by Koh, Shibani, Tan, & Hong (2016) presenting a LA system based on an explicit pedagogical model, called the Team and Self Diagnostic Learning Framework (TSDL). Their LA solution is, so far, not based on analysing Big Data on students' actions, which distinguishes it from other proposals within the field. In their team competency awareness program, Koh et al. (2016) decided to utilise existing surveys from social sciences and represent their results in a visual form. Those so-called dispositional analytics (Shum & Crick, 2012) were used to guide students in reflecting upon their team collaboration in order to build self and team awareness. The 14-years-old students worked in groups on collaborative inquiry tasks and were afterward asked to fill in an online survey based on teamwork competency dimensions. The results of the survey were then represented on a radar chart showing a micro-profile of teamwork competency of an individual, according to both himself and his peers. In the next step, the students were asked a range of questions designed to help them make sense of the data and how it could be used to improve the group performance. Both students and teachers were generally positive about the experience, with students saying that it supported them in gaining a better understanding of how well they did in teamwork and how they were perceived by others. The main challenge reported by Koh

et al. (2016) was related to finding time in the busy school schedule when the students could participate in the sensemaking part of the framework.

When it comes to LA features aimed for the tutors rather than students, probably the most common role of the analytics is providing tutors with information needed for various interventions (Herder et al., 2018; Lonn, Krumm, Waddington, & Teasley, 2012; van Leeuwen, Janssen, Erkens, & Brekelmans, 2014). Herder et al. (2018) aimed at creating a tool to support teachers' interventions in a virtual internships systems. The Process Tab tool was meant to represent and visualise the discussion of both groups and individuals. Teachers were given access to a 'summary view' showing the quality of the contributions made by individuals, network models, but also suggested interventions. The LA features were updated in real time, so the teachers could at any time during class access the system and see who needed support. However, even though the teachers saw the potential of using the tool, they did not really utilise it, as they were not able to find time to consult the LA features during the busy classes. Moreover, even though the tool was analysing contributions to discussions, it seems that the focus were individual contributions rather than the group-level analysis.

Another example of a learning analytics tool to support teachers' diagnosis and intervention, was suggested by van Leeuwen (2014). The experimental study utilised learning data collected on student activities in past courses. The teachers in the control group had access to all of the students' activities that had taken place in a chat tool and a shared text editor. The experimental group had the option of using two additional features, a pie chart with the relative contribution made by the group members, and a visualisation of the group's level of agreement/disagreement based on the content of the chat tool. The teachers were presented with vignettes showing collaborative situations representative of groups with different problems. They were asked to rate each group's participation and discussion and had an option of sending an intervention message. The results showed that the teachers who had access to LA features were able to give more details when explaining the score that they assigned to the groups, were more successful in spotting the participatory problems in collaboration and intervened more frequently. Interestingly, the visualisation of group's disagreement had an unclear effect, with teachers in experimental conditions not being able to point out the groups that showed signs of discussion problems. While some of those results are promising, the study was run using data from the past, and thus did not investigate how the fact that the teachers had access to the analytics influenced the learning experience of the students.

Forums are one of the most commonly used collaborative online tools (Bakharia & Dawson, 2011) that in majority of LMSs are analysed only on a very basic level. However, there is a significant body of research (de Laat, Lally, Lipponen, & Simons,

2007; Luhrs & McAnally-Salas, 2016; Romero, López, Luna, & Ventura, 2013; Suraj & Roshni, 2015), focused on investigating forum interaction and participation using social network analysis (SNA). One of the examples is The Social Networks Adapting Pedagogical Practice (SNAPP), a tool which offers a real-time SNA using various algorithms in order to support teachers in finding and understanding the different network structures (Bakharia & Dawson, 2011). Among other functionalities, SNAPP provides interactive visualisations of the network and helps the forum facilitators in locating isolated students, identifying and acting upon network patterns (e.g. facilitator-centric pattern), or discovering the emergence of sub-groups and cliques.

Rabbany, Takaffoli & Zaïane (2012) propose another LA tool utilising SNA, called Meerkat-ED. This toolbox builds two types of networks, one of them concerned with the interaction between students (social network of students) and the other one that provides a hierarchical visualisation of topics (network of phrases). Rabbany et al. (2012) argue that this additional feature allows the teacher to see which topics were addressed in the discussion, which students participated in those topics, and how active they were. The case study showed that the teachers found Meerkat-ED to be a valuable tool that allowed them to get an overview of the students' participation in the forum, and identify both the influential students, as well as, the lurkers.

An interesting implementation of LA for collaboration, AMOEBA, was proposed by Berland, Davis, & Smith (2015). The function of the tool was to support the teachers in pairing the novice programmers at the middle school and high school level to best facilitate collaboration. The system runs a real-time analysis of the progress that students are making in their programming tasks, tracks which students work in a similar manner, and based on that provides the teacher with recommendations on how to pair students to improve learning. Berland et al. (2015) showed results according to which the students whose teams were created with help of AMOEBA improved in terms of their code's complexity and depth.

Self-directed learning

Self-direction is a quality of learners who take initiative and responsibility for their own learning (Hiemstra, 1999). Self-directed learning (SDL) and self-regulated learning (SRL) are terms that are often confused or used interchangeably (Gandomkar & Sandars, 2018). While the two concepts share some similarities, there are certain differences between them. Gandomkar & Sandars (2018) explain that while SDL can be seen more as an approach to learning that a learner can take up and follow, SRL is a strategic and dynamic process that a learner utilises to ensure that she achieves her learning goals. As successful SDL must first be successful SRL, we decided to include examples of LA solutions that directly mention either SDL or SRL.

Dawson, Macfadyen, Risko, & Foulsham (2012) proposed the use of The Collaborative Lecture Annotation System (CLAS) in order to encourage self-directed learning among students. CLAS is a video annotation tool that allows the students to annotate important points in a video, share their annotations and review annotations made by others. The access to their own annotations combined with the ability to compare with peers helps the students to reflect on the significance of different points in the video and supports the instructors in checking whether the students recognised the important concepts. Dawson et al. (2012) argue that the tool helps students to develop their self-monitoring and self-management skills thus assisting them in being self-directed learners. Risko, Foulsham, Dawson, & Kingstone (2013) ran a user experience study of CLAS and reported that students found it useful to have access to the group graph that helped them find important information in the video and considered the annotation tool easy to learn. While the proposed tool was interesting, it was not reported whether it actually succeeded in encouraging self-directed learning by increasing motivation, supporting self-monitoring and self-management.

Analytics for Everyday Learning (AFEL) project attempts to address the issue of collecting and combining data from different sources and platforms (Holtz et al., 2017). Among its expected outcomes is a set of tools that would allow users to track their online learning activities in order to support self-directed learning. Holtz et al. (2017) describe a browser extension that extracts search history, which is later analysed to derive topics that are divided into clusters to obtain a set of broader themes. The data from this analysis is then fed to an interactive dashboard with several visualisations that students can adjust to their needs, including an overview of the larger themes, together with information on the relative number of learning activities associated with each topic. Another feature allows the user to track their learning intensity and progress, in relation either to specific topics or all of their learning activity. The dashboard also provides resource recommendation based on students' learning situation. The AFEL tools are still at an early stage of development, so they not only need further work but also lack feedback from users, which means that their positive influence on self-directed learning capabilities has not yet been shown.

Tabuenca, Kalz, Drachsler, & Specht (2015) conducted a study that explored the effects that regular tracking of the time spent on learning activities has on self-regulated learning. The authors provided the students with two tracking tools: an Android app and a multiplatform web interface, combined with SMS notifications. The results of the study showed that logging time spent on studying might lead to an improvement of time management skills and time planning, as assessed through questionnaires on self-regulation. The time of the notifications mattered, with randomly timed notifications having no positive influence on time management, and fixed-time notifications showing

a potential of improving time management skills. The influence of tracking on learning varied depending on the tracking option used, partly because participants using the mobile app tended to be more consistent and regular in their logging. Tabuenca et al. (2015) also showed that notifications including personal LA influence time management slightly more positively than notifications that consisted solely of generic tips regarding self-regulation. Interestingly, the authors reported a lack of correlation between the number of time logs, the duration of the logged time slots, and grades obtained by the participants.

One of the topics that Tabuenca et al. (2015) touched upon in their work is providing the students with valuable feedback in order to support their learning regulation. According to Sedrakyan, Malmberg, Verbert, Järvelä, & Kirschner (2018), the field still lacks the knowledge and guidelines in regard to the design of actionable feedback based on the learner's goals and characteristics. The existing tools often fail in increasing learners' motivation or helping them develop a mastery orientation, and do not provide support that could help students make sense of the visualisations and regulate their learning to do better. Sedrakyan et al. (2018) address those deficits by proposing a model listing the concepts recommended in relation to designing regulation-supporting feedback in LA dashboards. The model includes several design implications concerning different aspects of the design of dashboards, such as the need for the environment to give students a possibility of having a planning profile, understood as a collection of different features that allow for setting sub-goals, creating learning plan, assigning resources, and allocating time. The dashboard environment should also support the students in monitoring their goals to help them adjust their plans and strategies and provide information on whether students' adaptation to certain challenges was successful. Some other recommendations include the need to give students and teachers control over aspects of the feedback they receive, and to offer both cognitive and behavioural types of feedback.

Reflection

LA tools aimed at supporting reflection often focus on analysing and facilitating reflective writing. It has been agreed throughout educational research that reflective writing is a process important for effective reflective practice, activating students and increasing engagement (Bolton, 2005; Thorpe, 2004; Towndrow, Ling, & Venthan, 2008). However, its use in education is challenged and limited by the time-consuming process of assessment and providing feedback. Currently, the contents of students' reflections are more often than not analysed manually, making it challenging to include reflective writing in courses where the ratio of teachers to students is low. It is not uncommon for facilitators in different PBL implementations to be responsible for guiding a high number of students. In some cases, one tutor may be responsible for facilitation in a classroom consisting of a few hundred students (Nicholl & Lou, 2012). Here the answer could be designing learning analytics for an automatic detection (Ullmann, Fridolin, & Scott,

2012) and assessment of reflection, combined with automatic actionable feedback (Gibson et al., 2017).

One of the main challenges that come with providing feedback is the analysis and assessment of reflective texts. While reflection is not really a new concept in education (Ullmann et al., 2012), the methods for assessment of reflective writing are still a work in progress and not yet fully established. This means that researchers who aim to design LA for reflective writing need to first adapt existing or develop a new assessment method/framework to be used for their tool (Gibson et al., 2017; Kovanović et al., 2018). Before reflective text can be assessed and feedback can be provided, it is first necessary to detect reflection in written text, which is in itself a challenging task, at least partly due to the lack of a large corpus consisting of reflective texts that could be used to refine the machine learning algorithms (Ullmann et al., 2012).

Ullmann et al. (2012) ran a study in which they developed a tool for automatic detection of reflection and made a comparison between the work of the automated systems and human ratings given access to the same texts. In the study, a framework based on five different elements of reflection was used to distinguish between reflective and non-reflective texts: description of an experience, personal experience, critical analysis, taking perspectives into account, and outcome of the reflective writing. A set of indicators together with rules were developed to locate the elements of reflection. The text was considered reflective if a certain number of indicators for each of the reflection elements was found within it. The results showed that the texts automatically categorised as reflective were also rated higher in terms of the quality of reflection by the human raters, which is promising for the further development of automated systems recognising and assessing reflective texts.

Gibson et al. (2017) report on the developments made by Authentic Assessment Analytics for Reflection (A3R) research project, which aimed to not only analyse the reflective texts but also to investigate the potential of providing automatic feedback that could inspire students to undertake actions that could improve their reflective writing. The project utilised and further developed an existing platform AWA (Academic Writing Analytics). Gibson et al. (2017) proposed a new conceptual framework for reflective writing, consisting of three moves (context, challenge, change), a modifier based on whether the students linked any of the moves to themselves, and three expression types (emotive, epistemic, critique). The text was annotated, with comments on paragraphs supplied in the margins, and expressions marked with symbols representing different elements of the described framework. The feedback was context-independent and not very detailed. Many of the students considered the feedback given to them helpful for their reflective writing and liked being able to see where improvement was needed. However, some

participants wished to be given more information on how to improve and felt that the comments were not clear enough. The evidence of action was limited, though the students who did modify their drafts, showed improvement in the quality of reflection. Gibson et al. (2017) discuss the need of including the contextual feedback that would also allow for providing more details and making the feedback more understandable.

DISCUSSION

At a first glance, the relationship between PBL and LA appears ambiguous. On one hand, Wilson, Watson, Thompson, Drew, & Doyle (2017) point to the existence of a potential conflict between the LA's goal of facilitating personalised and individualised learning, and the collaborative, social idea of learning that underpins social constructivist learning theories. On the other hand, Blikstein & Worsley (2016) argue for the contribution that MMLA can make to understanding and promoting constructivist forms of learning. The goal of this paper was to investigate the potential connection between LA and PBL. The field of LA is still young, and new solutions are constantly being developed. While not many of them specifically mention PBL, there is a significant body of research, referring to some of the PBL central themes, collaboration, self-direction, and reflection. In our work, we described and discussed representative examples of tools developed to measure, assess, and support the learning processes and skills associated with those central themes. Now we use these examples in order to examine what we can learn from them in order to help pinpoint both the possibilities and the challenges of employing LA to support PBL. We give special focus to the future research implications associated with these challenges in order to provide a foundation to move forward.

Possibilities

The examples that we described show that skills and themes associated with PBL are gaining attention from the LA community. They also represent a piece from the variety of work that has already been done and is currently being undertaken in the field of LA. Even though the described tools are often in their early stages of development and have not yet been integrated into any specific program or institution, they do show a promise of supporting both learners and facilitators in their everyday PBL practice.

Perhaps the most important role that LA can play in the PBL process is the one of supporting students in the development of their PBL-related skills. We described the examples of LA tools developed to provide students with information, usually in form of visualisations, on their collaborative skills (Koh et al., 2016), or quality of their reflective writing (Gibson et al., 2017). With use of different LA features students were able to monitor progress in different learning topics (Holtz et al., 2017), track their learning

patterns over time (Tabuenca et al., 2015), and compare their judgment with others (Dawson et al., 2012), and thus, gain the information and support needed for successful self-directed learning.

Majority of the described tools were directed to facilitators rather than students, which may be associated with the fact that it is easier to provide the facilitators with additional information rather than creating automatic actionable feedback aimed directly at students. The facilitators were presented with a variety of different tools and visualisations. The described solutions show that LA have a potential of supporting facilitator in a variety of ways, such as overseeing the collaboration between students (Herder et al., 2018; Hogaboam et al., 2016; van Leeuwen et al., 2014), providing first assessment of reflective writing (Gibson et al., 2017), or giving an overview of whether students managed to find the important information in video material (Dawson et al., 2012). Some of the ways in which data was used to support collaboration, was assigning students into groups based on their collaboration patterns (Berland et al., 2015), or identifying participation problems or arguments (van Leeuwen et al., 2014). The overview of tools shows the potential that LA have not only for assisting students but also for significantly reducing the workload of teachers. However, it is also clear that the strong focus on the facilitators, rather than the students, sits somewhat uncomfortably in a PBL context.

Challenges and implications for the future

Involving users in the design

The challenges associated with developing LA for PBL do not much differ from those that the LA field as a whole is still encountering. One of them is related to giving more attention to the supply side rather than the demand side (Ferguson et al., 2016). This means that there is a stronger focus on answering the needs at an institutional level, than on developing tools that teachers and students could use to support the teaching and learning processes. As a result, users often do not know how to make sense of the visualisations that are presented to them (Hogaboam et al., 2016), find the provided information insufficient (Gibson et al., 2017), or have difficulty integrating the tool in their existing practice, e.g. due to time constraints (Herder et al., 2018; Koh et al., 2016). Not including the perspective of students and other stakeholders in the design process is a problem that the LA field has been facing since its creation (Ferguson, 2012; ‘General Call | Learning Analytics & Knowledge 2017’, n.d.). Even though there is no lack of student-facing LA tools, the students are rarely actively involved in the design, and the information of how they perceive usability or usefulness of the LA system is not provided (Bodily & Verbert, 2017). This should be done in order to ensure that those tools really

answer their needs (Kilińska, Kobbelgaard, & Ryberg, 2018) and can be successfully included in the existing learning and teaching practices.

Designing a practice

The examples also provide a further base for the argument already voiced by some LA researchers (Mangaroska & Giannakos, 2018; Wise, 2014), which is that it is not enough to create LA tools. What also needs to be considered is the practice surrounding the use of those tools in regard to agreeing on the goals, assigning time, and providing guidelines for making sense of the presented information. Out of the described LA solutions, only one (Koh et al., 2016) included features for supporting the process of reflection and planning actions to be taken based on the information from LA tools.

Building a holistic picture of learning

Many of the current LMS tools do not paint a very holistic picture of the learning process as they do not collect the data from many sources, but focus e.g. only on data available LMSs. The work meant to combine data from different sources and platforms has already started (Holtz et al., 2017) but it is still in its infancy. The challenge comes from the high complexity and diversity of the learning ecosystems used by students. In many cases, e.g. within Aalborg University's PBL Model, Moodle is often used to a very limited extent, and it is up to the students to find a combination of tools that suit their learning needs (Caviglia, Dalsgaard, Davidsen, & Ryberg, 2018; Sørensen, 2018). Some educators attempt to create their own version of PBL-friendly systems, either by making one from scratch or developing plug-ins for the LMS used by their institution (Ali, Al-Dous, & Samaka, 2015). Therefore, it is important that future research focuses on understanding and mapping the learning ecosystems. What is also very promising, is further development in the area of MMLA that attempt to combine the data on online activity with face-to-face data. It must be noted, however, that building MMLA solutions faces many technical challenges (Ochoa & Worsley, 2016).

What should also be considered, is development of LA based not only on automatically logged data on students' activities, but also self-reported data, as we saw e.g. in the work of Koh et al. (2016). Some argue that the numbers alone are not enough, as what remains unknown is the intent (Ellis, Han, & Pardo, 2017), and without the knowledge of the full context, it is difficult to analyse the data. Even when the external learning conditions are the same, internal conditions may differ significantly (Gašević, Dawson, & Siemens, 2015). Combining the automatically recorded logs with self-recorded data may be a way of gaining a greater understanding of the actual learning processes (Ellis et al., 2017), but so far this solution is rarely utilised in the field of LA (Tempelaar, Rienties, & Giesbers, 2015).

Providing actionable feedback

What still requires further work is providing students, also those who already do well in the course, with actionable feedback that can help them improve their work (Sedrakyan et al., 2018). Out of the presented LA solutions, only a few aimed at giving the students automated feedback that they could later actively use (Gibson et al., 2017; Tabuenca et al., 2015), and even then, some of the students reported that they did not know how to use the information to, e.g. further develop their reflective writing skills. In order to address this and other shortcomings, the field needs to work on its connection to the learning sciences and educational research (Ferguson, 2012; Ferguson et al., 2016; Gašević et al., 2015; Mangaroska & Giannakos, 2018; Sedrakyan et al., 2018).

Establishing collaboration between PBL and LA researchers

The field of LA is working on creating stronger connections to learning sciences and educational research, but in most cases, it is not quite there yet. The main implication that seems to be coming from this fact is that if the LA solutions are to really support the PBL principles, what needs to be considered is an active collaboration between PBL practitioners and LA researchers to create tools that are rooted in the existing practice and educational knowledge of the field of PBL. This collaboration could lead to the development of further frameworks and guidelines for the design of future LA solutions to ensure their adherence to PBL principles and thus wider adoption of the created tools. What is important, is for the future PBL tools to be flexible and easily adapted to the needs of specific users and settings. There is no one model of PBL that is implemented in single format at all institutions, which makes it challenging to apply one set of generalizable practices and concepts to analyse and assess learning within PBL (Savin-Baden, 2004).

CONCLUSION

Even though the existing LA tools supporting PBL or PBL-related themes still have significant limitations, the ideas that they represent are valuable. In the era of a growing popularity of online learning and MOOCs, it is necessary to develop and provide tools that will make it possible to implement PBL process in different settings, also those that cannot afford the number of facilitators sufficient for effective support of all the enrolled students. Automation of feedback and assessment provide an opportunity for employing PBL at a larger scale, not only in small classrooms, while preserving its main principles. LA tools do have the potential to support students in developing collaboration, reflection, and self-directed learning skills, and to give the teachers information that can help them provide successful facilitation. Moreover, as the field is still struggling with making the

connection to the learning sciences, PBL practitioners can offer their experience, expertise, and critical perspective, to ensure that LA are indeed about learning, and not about showing performance. From the economic and institutional perspective, if constructivist approaches to learning are to maintain their position in education and continue to be adopted, they could potentially need to address the administrative limitations that are currently holding them back. LA, or specifically MMLA features are a way to possibly analyse and quantify non-traditional (or non-behaviourist) approaches to learning in order to give them an advantage in the educational systems driven by the political and economic need to demonstrate performance (Blikstein & Worsley, 2016). It may therefore be a smart move for PBL practitioners to engage with the field of LA, not only to benefit from the information it provides, but also to gain a voice in the change processes associated with the institutional and political adoption of digital technologies and LA. As we briefly discussed in the section *The reasons for the continuous growth of the field*, there are different perspectives driving the interests within LA: a research-led perspective focusing on learning, but equally a political-institutional perspective driven by an interest in increasing retention and minimising drop-out rates. While the latter is commendable, we need, as PBL practitioners, to ensure that adoptions of LA within PBL-institutions empower students and support collaboration, self-directed learning, and reflection.

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Web 2.0 Technologies Supporting Problem-Based Learning: A Systematic Literature Review

Erhan Ünal *

ABSTRACT

The purpose of this study was to investigate the study general trends with regards to Web 2.0 technologies supporting problem-based learning (PBL) environments. A systematic literature review was applied to analyse studies published in this area, with a total of 18 articles included in the review. The content analysis method was applied in the study. The results indicated that the emergence of studies in this area was in 2007. The studies were conducted in different research domains. The qualitative research paradigm was the most frequently used, and higher education students the most preferred study group in the articles. Wiki was the most integrated Web 2.0 tool in PBL environments. Interview was the most selected data collection tool, with qualitative analysis methods the most used in the articles. The variables investigated the most in the studies were perception about the effectiveness of PBL and achievement. The effectiveness of Web 2.0 technologies supporting PBL was the most frequently reported finding. Therefore, the current study was able to identify the recent trends in this research area. Based on the results, the study put forward suggested implications for future research.

Keywords: Web 2.0 technology, problem based learning, systematic review.

INTRODUCTION

Problem-based learning (PBL) first emerged in the 1970s at McMaster University in Canada. The need for PBL was that students at the university's medical faculty had become disinterested with the traditional methods of learning, and were experiencing difficulties in transferring their gained knowledge to the real world. Therefore, PBL was

* Erhan Ünal, Faculty of Education, Department of Computer Education and Instructional Technology, Afyon Kocatepe University, Afyonkarahisar, Turkey
Email: eunal@aku.edu.tr

first implemented in the medical curriculum as a means to overcome those problems (Barrows, 1996). Since PBL first emerged, it has since been developed and implemented across different education contexts and from K-12 through to the institutions of higher education. However, with the advent of technology, computers and other related tools, known collectively as cognitive tools (Jonassen & Reeves, 1996), can all be utilised within the PBL environment. Therefore, researchers have integrated different technological tools such as virtual worlds (e.g., Beaumont, Savin-Baden, Conradi, & Poulton, 2014; Good, Howland, & Thackray, 2008), online chat applications (e.g., Donnelly, 2010; Hashim et al., 2017), 3-D technologies (e.g., Omale, Hung, Luetkehans, & Cooke-Plagwitz, 2009), online course management systems (e.g., Baturay & Bay, 2010; Delialioğlu, 2012), and dynamic web technologies (e.g., Huang, Huang, Wu, Chen, & Chang, 2016; Jaffar, 2012) into the PBL environment. According to literature based on technology-enhanced PBL environments, Web 2.0 technologies have been investigated in a number of studies. Therefore, the primary focus of the current study was to systematically review published studies that were conducted in the field of Web 2.0 technologies supporting PBL environments.

Problem-Based Learning

PBL is an instructional method based on experiential learning (Hmelo-Silver, 2004). 'PBL is the learning that results from the process of working toward the understanding or resolution of a problem' (Barrows & Tamblyn, 1980, p. 1). PBL is an instructional method in which students are confronted with authentic problems, and in which they learn knowledge through the problem-solving process (Hung, Jonassen, & Liu, 2008). According to the definitions of PBL, learning is a problem-solving process. In PBL, students should become active learners in order to solve problems. When students are presented with a problem, they work in groups, analyse the problem, determine what they know about the problem and which knowledge is needed to solve the problem, synthesise the knowledge, and then attempt to solve the problem (Hmelo-Silver, 2004; Jonassen, 1997). As a theoretical basis, PBL is grounded on constructivism. According to the learning principle of constructivism, knowledge is socially co-constructed based on the individual's interpretation of the external world (Jonassen, 1997), and students' construction of knowledge is an active process (Duffy & Cunningham, 1996). In this regard, students should participate in PBL activities such as problem analysis; communication and collaboration with students, teachers, and others; studying resources; and, actively generating discussion with other students.

Problem-Based Learning and Web 2.0 Technologies

In PBL activities, technology usage in the PBL environment is an important issue. In this regard, Web 2.0 technologies are considered a good option to support the PBL environment due to their various advantageous aspects (Thomas & Li, 2008) being consistent with the learning principles of PBL. Different Web 2.0 technologies such as collaborative tools, audio tools, video tools, and image-based tools can be used in support of learning in the PBL environment. Students can utilise Web 2.0 technologies in order to search for information, access resources, communicate and collaborate with their student peers and teachers, as well as generally interact with other students, resources, and teachers during the PBL activities.

In the literature, a number of studies have been conducted with regards to the use of Web 2.0 technologies in the PBL teaching and learning environment. Researchers have undertaken such studies based on different Web 2.0 technologies. For example, Robertson (2008) incorporated wiki technology to design a blended PBL environment, with wikis used in order to support problem-based and group-based learning and assessment. In another study, Lo (2009) used blogs, wikis, and instant messaging tools within the online PBL environment to accomplish various steps of PBL. Similar to Lo's study, Pardo and Kloos (2009) used a learning management system within a PBL environment, incorporating modules on discussion, wikis, and file storage. Students then applied these modules within the PBL process. Duncan (2009) used wiki technology within an online PBL environment, with students using wikis to facilitate the learning process in PBL. In another study, Tambouris et al. (2012) developed a platform for usage in a PBL environment that was based on the affordances of Web 2.0 such as collaboration, sharing, support, and discussion, in which the students evaluated the platform with respect to four courses. In a more recent study, Virtanen and Rasi (2017) integrated blogs, interactive online wall and board functionality, a chat tool, and a mind-mapping tool into the PBL process of a course on Moving Images in Teaching and Learning. The tools were used within the different steps of PBL for the storing, production, and sharing of the course content. Considering these various interrelated studies, it could be said that the features of Web 2.0 tools are in congruency with the principles of PBL, and that such studies tend to focus on the integration of these tools into the PBL teaching and learning environment. Therefore, researchers have conducted their studies on integrating Web 2.0 tools with PBL according to the context.

Although there have been several studies about using Web 2.0 technologies in the support of PBL, to the researcher's knowledge there has been no systematic review performed with regards to this topic area that has examined articles related in terms of their methodology, study group, and educational contributions. However, there are reviews about how web 2.0 technologies are used in education. For example, Conole and Alevizou

(2010) published a report reviewing studies from the perspective of Web 2.0 technologies' benefits and limitations in higher education. Liu, Kalk, Kinney, and Orr (2012) analysed conference papers published from 2007 to 2009 related to the use of Web 2.0 technologies in higher education, and a focus on the educational purposes of Web 2.0 technologies in higher education. Cheston, Flickinger, and Chisolm (2013) conducted a review about the use of social media in medical education, focussing their study on the methodologies, social media tools involved, and the educational output in that context. In another study, Hew and Cheung (2013) reviewed the literature about the use of Web 2.0 technologies for teaching and learning in both K-12 and higher education. The researchers examined published studies in terms of the Web 2.0 tools used, as well as research discipline, learning objectives, and pedagogical approach. In a study by Tsai and Chiang (2013), the researchers analysed empirical online PBL studies in SSCI-indexed journals published between 2004 and 2012.

Summarily, it can be seen that the literature has mostly focused on the educational contributions of Web 2.0 technologies in learning environments. Therefore, the researcher considers it would be useful to conduct a systematic review regarding the topic of Web 2.0 technologies supporting PBL environments as systematic review studies can provide vital information to researchers about the current direction and trends of research in the area (Kitchenham, 2004). Therefore, the current study aims to be of significance in helping researchers to understand the current situation, new trends, and potential future research areas with regards to Web 2.0 technologies supporting PBL. Additionally, policymakers could utilise this study's results to develop future plans for integrating Web 2.0 technologies into PBL environments.

Purpose of the Study

The purpose of the current study was to investigate the general trends in Web 2.0 technologies supporting PBL studies indexed in the Web of Science and ERIC databases between 2004 and 2018. The following research questions were addressed in the study:

1. What is the distribution of the studies by years?
2. What is the distribution of the studies by research domain?
3. What research paradigms and methods are most commonly used in the studies?
4. What Web 2.0 technologies are most commonly used in the studies?
5. What sample groups are most commonly preferred in the studies?
6. What data collection tools are most commonly preferred in the studies?
7. What analysis methods are most commonly preferred in the studies?
8. Which variables do the studies most commonly investigate?
9. What findings do the studies most commonly report?

METHOD

A systematic literature review was applied in order to analyse studies published on Web 2.0 technologies supporting PBL. Systematic literature review is 'a means of identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest' (Kitchenham, 2004, p. 1). Therefore, the following review process was adopted from the literature (Kitchenham, 2004; Moher et al., 2015).

Search Strategy

1. The researcher identified the databases upon which the search for articles would be performed, and the types of articles that were being sought. The search was conducted based on the Web of Science database with journals indexed as SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, or ESCI and ERIC database. The reasoning behind the researcher's selection of these indexes was their known hosting capacity for high quality and relevant studies. Additionally, many reviews are known to have been published related to technology usage in educational settings (e.g., Hew & Cheung, 2013; Tsai & Chiang, 2013) based on similar database searches.

2. The article publication time period for the selected database searches was determined to be from February 2004 to February 2018 (performed as of 28 February, 2018). The reason for the search start being set as 2004 was the acknowledged emergence of Web 2.0 technologies having occurred in that year.

3. Keywords were identified and used within the advanced search function of each database. The primary keywords related to the topic were problem-based learning and Web 2.0 technologies. However, some authors had used different terms such as PBL instead of problem-based learning or social network instead of Web 2.0 technologies. Therefore, Boolean operators (And, Or) were applied in order to return more accurate results using the advanced search functionality. Searches were therefore performed using the aforementioned terms as (("problem based learning" OR "PBL" OR "problem-based learning" OR "problem-based" OR "problem based") AND ("web" OR "web 2.0" OR "dynamic web" "social media" OR "social network")).

Study Selection (Inclusion and Exclusion Criteria)

Once all the primary search results had been obtained from the selected databases, the inclusion and exclusion criteria were then determined by the researcher based on the research questions of the current study.

1. Articles were only included where they were based on the integration of at least one Web 2.0 tool into a PBL environment. According to this criterion, articles which only used PBL or Web 2.0 technologies in the learning environment, and not both, were excluded from the study.
2. Only published articles related to the topic were included in the review. Conference papers, editorials, reviews, or book chapters were excluded from the study in order to retain only high quality peer-reviewed published articles for the study.
3. Access was required to the full text of each article, and the article publication language was selected as English. Therefore, articles deemed to be published as 'abstract-only', were unable to be freely accessed, or where the publication language was other than English were excluded.

The first search yielded a total of 490 articles from the Web of Science database, plus a further 79 from the ERIC database. After scanning the titles and abstracts of each of the returned papers, a total of 222 papers from the Web of Science database and 46 from the ERIC database were initially selected to be included in the current study's review.

Next, the full text of each article (222 from Web of Science and 46 from ERIC) were examined in detail by the researcher. The reason for certain articles then being rejected included not having incorporated Web 2.0 technology integration in a PBL environment. Furthermore, as Boolean operators (And, Or) were applied to the search process, some of the articles included Web 2.0 technology integration in PBL environments, whilst others did not. Those articles which did not incorporate at least one Web 2.0 tool within a PBL environment were therefore excluded from the study.

When the inclusion and exclusion criteria was applied, the majority of the articles were found to have been rejected and therefore excluded from the study. In total, 18 articles (13 from the Web of Science and five from ERIC) were deemed to have fully met the current study's inclusion criteria and were selected for review (see asterisked items in the References section).

A summary of the data collection process is illustrated in Figure 1.

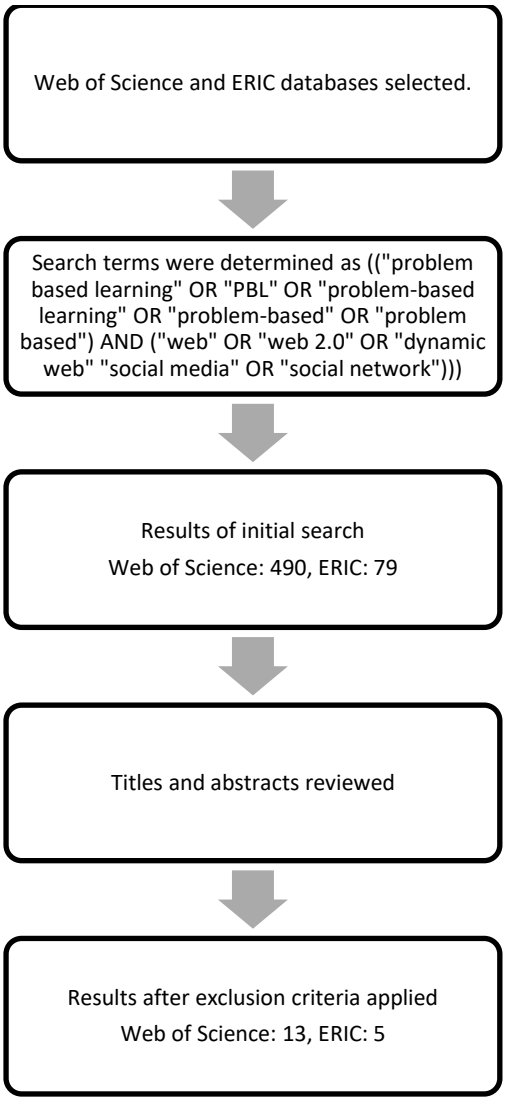

Figure 1: Data collection process

Data Coding and Analysis

In order to examine the selected articles in detail, the article review forms developed by Zheng, Huang, and Yu (2014) and Goktas et al. (2012) were adapted according to the research questions of the current study. The adapted article review form was then reviewed by two experts from the field of instructional technology in terms of its appropriateness and convenience. Based on the expert views received, the final article review form consisted of article identification tag, research domain, research paradigm, research method, Web 2.0 tool(s) (used in the article), sample group, data collection tool(s), data analysis method(s), dependent variable(s), and findings. Each of the sections of the form and their corresponding categories are explained in Table 1.

Section	*Category*
Article identification tag	• Title • Year • Keywords • Index
Research domain	• Natural Science (i.e., science, maths, physics, chemistry, biology, geography, environmental science, astronomy, architecture) • Social Science (i.e., politics, education, psychology, linguistics, art, law, literature, archaeology, philosophy) • Engineering & Technological Science (i.e., engineering, computer science) • Medical Science (i.e., health, medicine)
Research paradigm	• Qualitative • Quantitative • Mixed
Research method	• Experimental • Survey • Causal comparative • Case study • Phenomenological • Grounded theory • Action research • Explanatory design • Exploratory design • Triangulation design • Meta-analysis • Review
Web 2.0 tool(s)	• (as per the used Web 2.0 technology(ies) used)
Sample group	• Preschool education students • Primary education students • Secondary education students • High school students • Undergraduate students • Graduate students • Non-formal education learners • Teachers/Instructors/Academics
Data collection tool(s)	• Survey (e.g., attitude, perception, aptitude, personality tests) • Achievement/Performance Test

	• Observation • Interview • Data form (i.e., discussion transcripts, email, messages, video records, audio records, log data, think-aloud protocols, screens records) • Alternative measurement tools (i.e., performance test, diagnosis, concept map, portfolio) • Document • Reflection
Data analysis method(s)	• Descriptive (i.e., frequency, percentage, mean, standard deviation, graphical representation) • Inferential (i.e., correlational, *t*-test, ANOVA, ANCOVA, MANOVA, MANCOVA, factor analysis, regression-based, non-parametric test) • Qualitative analysis method (i.e., content analysis, descriptive analysis)
Dependant variable(s)	• Achievement • Perception • Motivation • Satisfaction • Other
Finding(s)	• (as per written outcomes according to findings and results)

Table 1: Sections of the article review form

The articles were analysed according to each section and their corresponding categories. Then, the data were coded using a form created in Google Forms by the researcher. The data were examined based on the content analysis method, which is a systematic technique for reducing text into more manageable data and then classifying the data into categories (Weber, 1990). For the purposes of ensuring the reliability of the data assessment, the researcher reviewed each of the articles at different times in order to achieve an acceptable level of get consistency. Furthermore, the researcher sought additional expert views for the article review process. Therefore, a reliable review process was deemed to have been conducted. Finally, frequencies and graphics were prepared in order to support the presentation of the results.

RESULTS AND DISCUSSION

Distribution of Studies by Years

According to the distribution of the articles by years, Web 2.0 technologies have been used in PBL environments since 2007 (see Figure 2). After the emergence of Web 2.0 technologies in 2004, integration of these technologies into PBL environments was seen in the subsequent years. However, the distribution of articles based on the use of Web 2.0 technologies in PBL environments over the years was found to be fairly consistent.

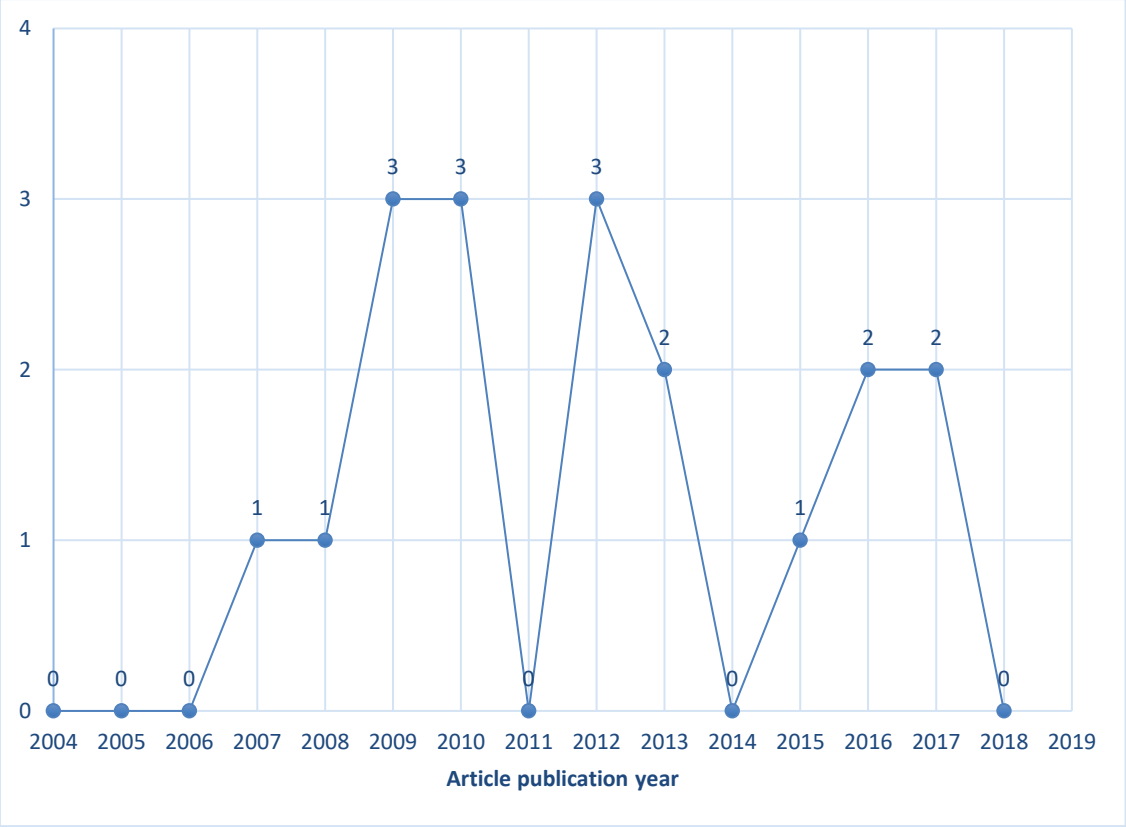

Figure 2: Distribution of articles by year of publication

Research Domain

Studies about Web 2.0 technologies supporting PBL environments were most commonly conducted in the Social Science (f = 8) research domain, followed by Medical Science (f = 6), Natural Science (f = 3), and Engineering & Technological Science (f = 1) (see Figure 3). PBL was first implemented in the field of medicine (Barrows, 1996), and has since been developed and implemented across different educational contexts. PBL has been shown to prepare learners to face real-world challenges (Hung et al., 2008), as well

as Web 2.0 technologies changing the learners role from passive to active learners in the learning process (Thomas & Li, 2008). The advantages of PBL and Web 2.0 technologies can lead researchers from different disciplines to conduct studies about Web 2.0 technologies supporting PBL environments. Therefore, it can be said that PBL environments supported by Web 2.0 technologies can be designed and investigated within different domains.

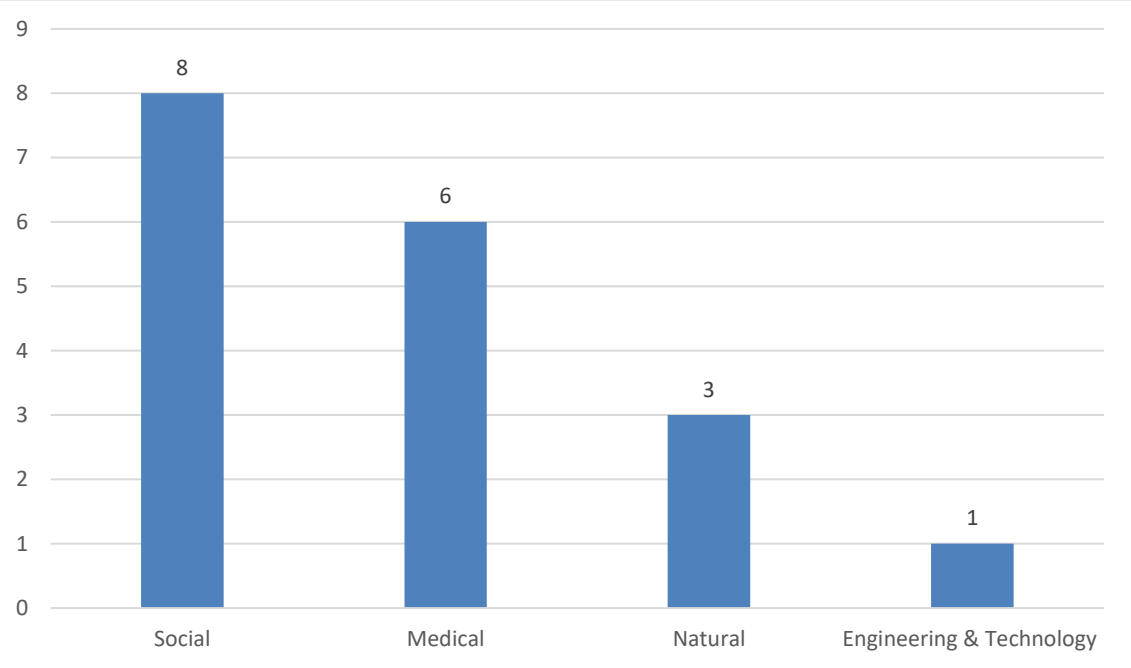

Figure 3: Number of articles by research domain

Research Paradigms and Methods

Most of the articles were conducted within the qualitative research paradigm (*f* = 9). However, mixed method (*f* = 6) and quantitative research paradigms (*f* = 3) were found to have been less preferred in the reviewed articles (see Table 2).

Research Paradigm	*Method*	*f*	*Total*
Qualitative	Case study	6	9
	Phenomenological	1	
	Not specified	2	
Mixed	Triangulation (quantitative + qualitative)	6	6
Quantitative	Experimental	1	3
	Causal comparative	1	
	Survey	1	

Table 2: Research methods and designs used in the studies.

On the other hand, when the research methods used in the articles were examined in detail, case study method (f = 6) was the most preferred among the quantitative paradigm. The phenomenological method (f = 1) was used in one article, while no method of study was mentioned in two articles. The triangulation method (f = 6) was preferred within articles conducted on a mixed methods basis. For the quantitative research studies, the experimental method (f = 1), causal-comparative method (f = 1), and the survey method (f = 1) were each seen in one article.

The case study method may have been preferred in the articles in order to investigate the effectiveness of Web 2.0 technologies supporting PBL environment. This method is often used in order to reveal the features of a learning environment, as well as to detect how the learning environment is seen and perceived by the participants (de Jong, Verstegen, Tan, & O'Connor, 2013). On the other hand, it was found that the triangulation method was used among mixed method research, and researchers used experimental design and qualitative research methods together. Thus, researchers were able to evaluate the effectiveness of Web 2.0 technologies supporting PBL environments and the effect of the environment on educational outcomes (e.g., Kay & Kletskin, 2012; Williams, Woodward, Symons, & Davies, 2010).

Finally, it was found that quantitative research methods were less frequently preferred in the articles. This finding contradicts with previous findings in the literature (Kucuk, Aydemir, Yildirim, Arpacik, & Goktas, 2013; Simsek et al., 2009). However, there is a need for further experimental studies about the topic (Kay & Kletskin, 2012; Pietikäinen, Kortelainen, & Siklander, 2017). Since experimental research attempts to reveal a cause-effect relationship between variables (Fraenkel, Wallen, & Hyun, 2012), the effect of Web 2.0 supporting PBL environments on educational outcomes could be investigated through an experimental design within a more controlled environment.

Web 2.0 Technology

Wiki (f = 9) was found to be the most preferred Web 2.0 technology reported in the reviewed studies. However, other tools such as blogs (f = 4), Skype/MSN (f = 3), discussion boards (f = 2), micro blogs (e.g., Twitter) (f = 2), Facebook (f = 2), and Backchannel chat or chat (f = 2) were found to have been integrated into PBL environment in fewer numbers of articles. Video podcasts, online mind-mapping tools, Backchannel tools, interactive whiteboards, YouTube, and interactive online wall tools were seen only once in the examined articles (see Figure 4).

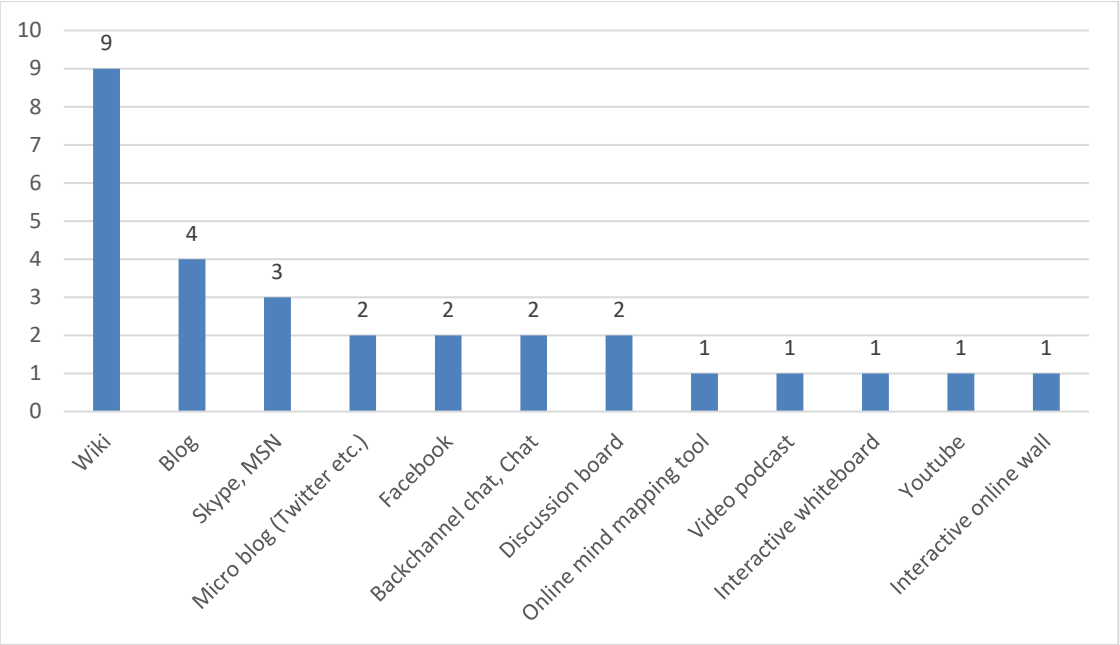

Figure 4: Web 2.0 tools used in studies

The reason why wiki technology was seen to be used more than other technologies within PBL environments may be that wiki as a tool allows for collaborative working. Collaboration is necessary within PBL during the process of knowledge construction (Doolittle & Camp, 1999; Schunk, 2012). It has also been seen in the literature that wikis can have an impact on the knowledge construction of learners (Biasutti, 2017; Fong, Chu, Lau, Doherty, & Hew, 2017; Matschke, Moskaliuk, & Kimmerle, 2013; Neumann & Hood, 2009). Additionally, social networks such as blogs, discussion boards, and Facebook were used in the PBL environments. The discussion environment facilitated by these tools can contribute to the social construction of knowledge. The other aforementioned Web 2.0 tools were also used within different PBL activities.

Sample Groups

Undergraduate students (f = 10) were the most frequently studied research sample, which was followed by graduate students (f = 4). A few studies were applied to sample groups of secondary school students (f = 2) and teachers and instructors (f = 2) (see Figure 5).

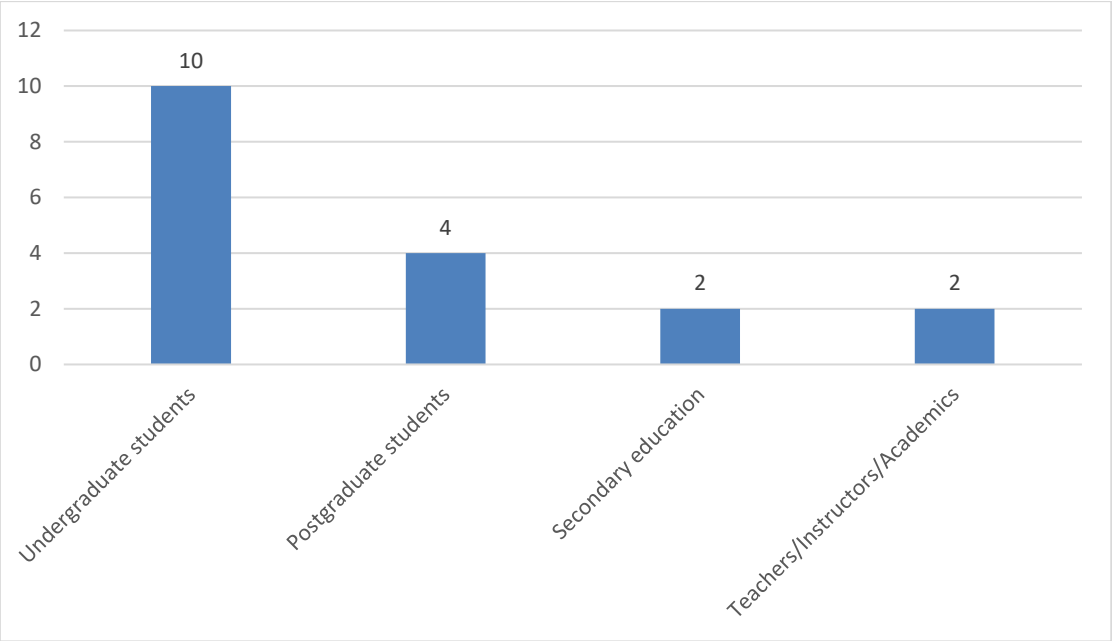

Figure 5: Distribution of sample levels

The finding that undergraduate students were the most studied the sample group is consistent with the literature (Hsu et al., 2012; Kucuk et al., 2013; Şimşek et al., 2009; Tsai & Chiang, 2013; Verstegen et al., 2016). There may be several reasons for selecting undergraduate students as the sample group of a study. First, researchers can readily access undergraduate students as the majority of researchers are university academicians or graduate students. Second, participants should have access to computers and the Internet in studies of Web 2.0 technologies supporting PBL environments. According to European Statistics (2018), 84% of individuals between the ages of 16 and 74 years old have access to computers, and that 87% have access to the Internet. Finally, the design of Web 2.0 technologies supporting PBL environments in higher education can be less challenging than for K-12 education, due in part to the flexibility of designing learning environments at the tertiary level.

Data Collection Tools

Regarding the data collection tools employed in the reviewed articles, it was found that interview (f = 12) was the most preferred tool for gathering data. While survey (f = 10), achievement/ performance test (f = 10), discussion transcripts, e-mail messages, and other records (f = 9) were frequently used in the studies, document (f = 2) and reflections (f = 1) were used in only a few studies to collect the data (see Figure 6).

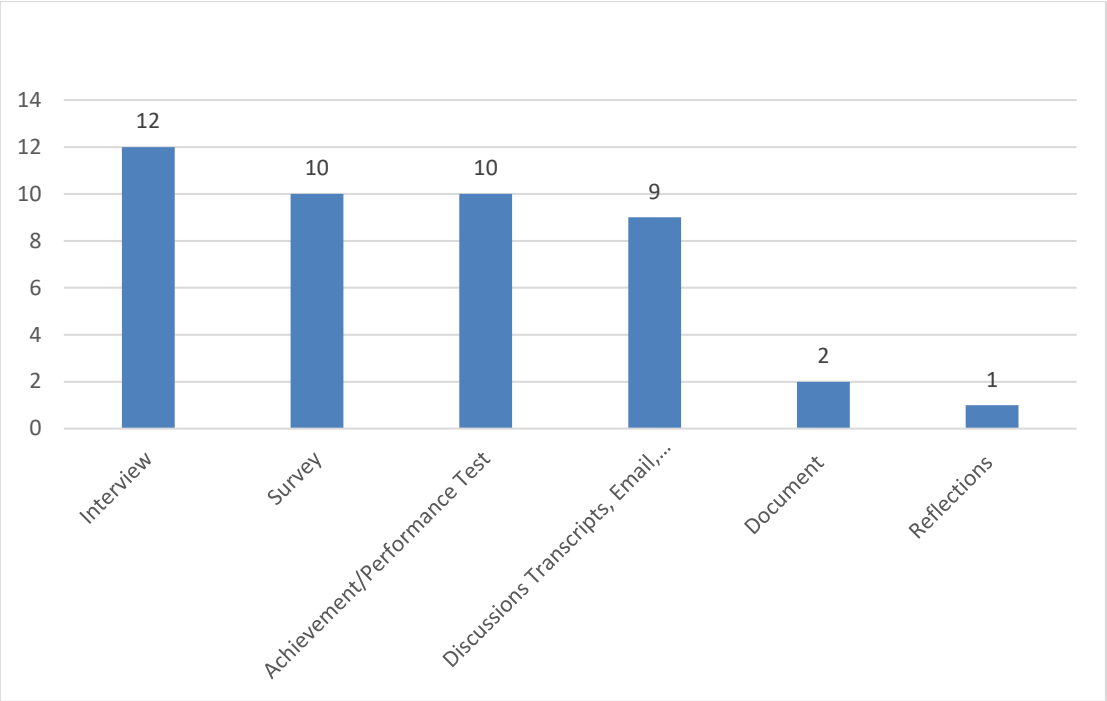

Figure 6: Distribution of data collection tools

Previous research results support the finding that surveys and interviews are employed the most in articles over other tools (Hew, Kale, & Kim, 2007; Kucuk et al., 2013. The reason for using the surveys as a data collection tool can be due to their low application cost, ease of copying, and for collecting data quickly (Baker, 2003). On the other hand, enabling researchers to conduct in-depth data collection can be the reason for conducting interviews as a data collection tool (Bogdan & Biklen, 2007). Achievement/performance test was also found to be widely employed in the articles. Other data collection tools such as discussion transcripts, e-mail messages, and other records were also used. Data such as log files and discussions were also collected from Web 2.0 technologies (e.g., de Jong et al., 2013; Varga-Atkins, Dangerfield, & Brigden, 2010). Document and reflections were only used in a limited number of studies, and in accordance with the research design.

Data Analysis Methods

The qualitative analysis method (f = 16) was the most frequently used data analysis method in the reviewed articles, followed by descriptive statistics (f = 12) and inferential statistics (f = 5), respectively (see Figure 7).

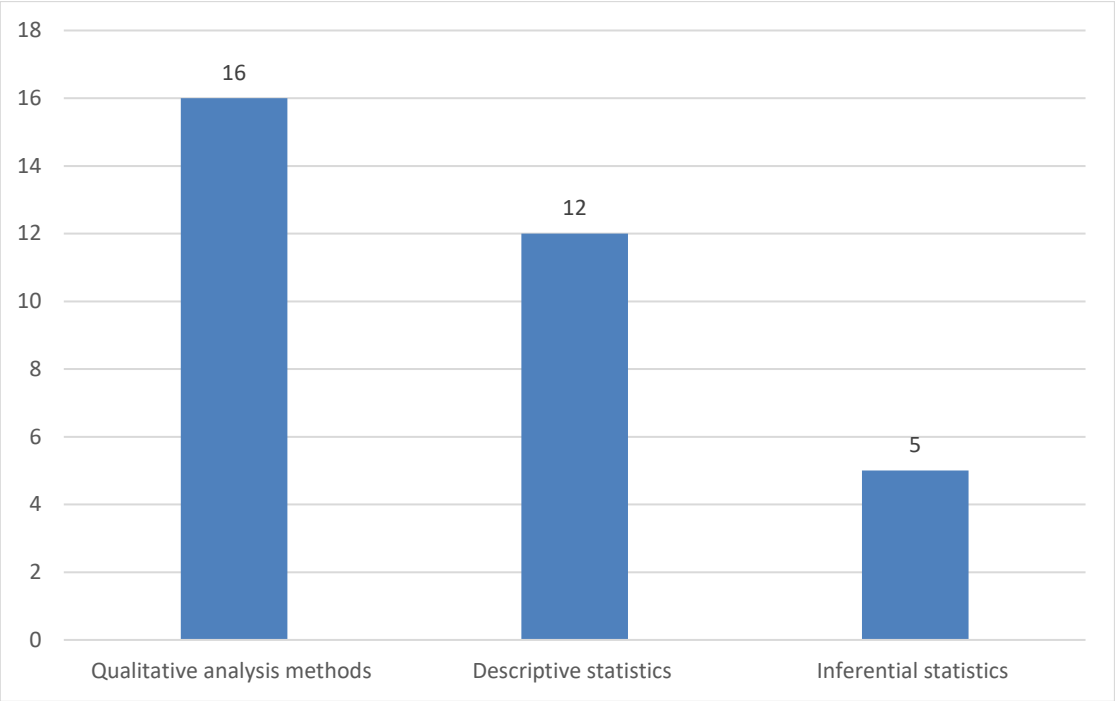

Figure 7: Distribution of data analysis methods

Employment of the qualitative research paradigm over others in the reviewed articles affects the analysis method/s used, hence the qualitative analysis method and descriptive statistics such as percentage, frequency, and average were the most preferred in the articles. This finding is consistent with previous studies (e.g., Hew et al., 2007; Kucuk et al., 2013 Şimsek et al., 2009). Inferential statistics such as correlation, regression, and variance analysis were less frequently used in the reviewed articles.

Variable

Perception about the effectiveness of PBL (f = 11), and its achievement (f = 10) were the most commonly investigated dependent variables in the reviewed articles. Satisfaction (f = 5), motivation (f = 2), collaborative affordances (f = 1), benefits of wiki (f = 1), engagement (f = 1), attitude (f = 1), and the effectiveness of YouTube videos (f = 1) were other variables investigated in the reviewed articles (see Figure 8).

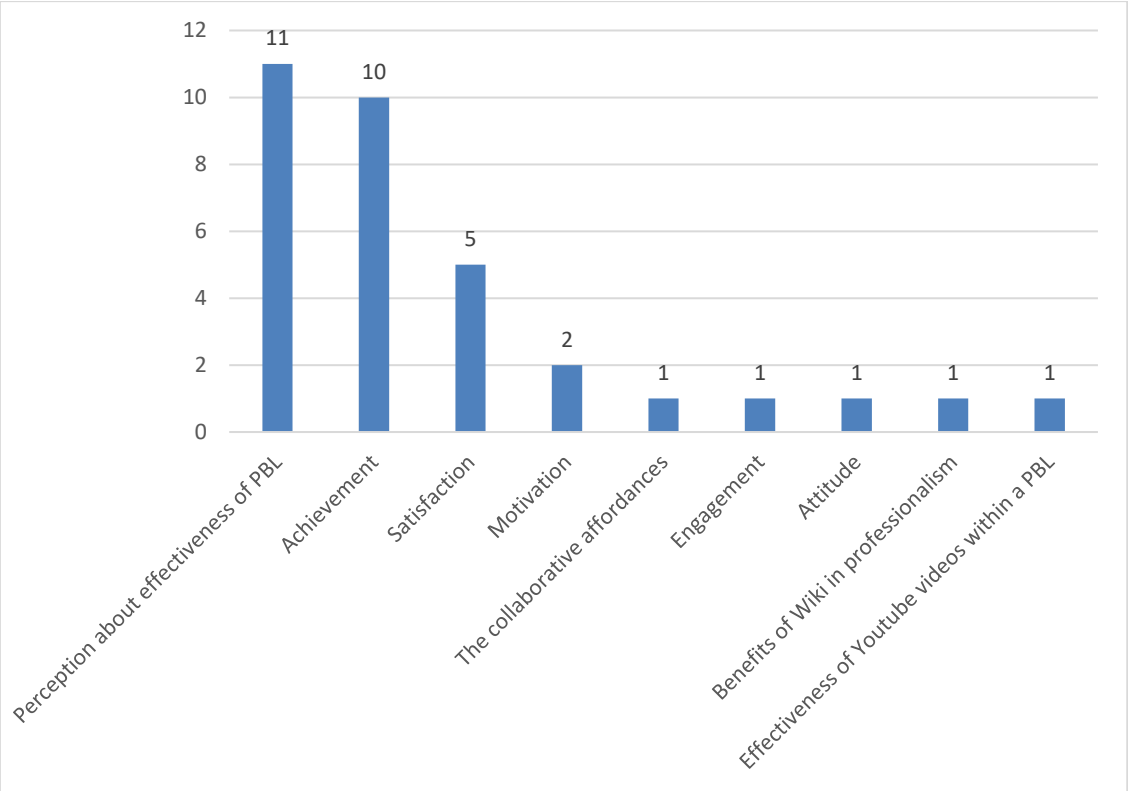

Figure 8: Distribution of variables

The use of different Web 2.0 technologies in research studies may lead researchers to examine the effect of Web 2.0 technologies supporting PBL environments on different educational outcomes (e.g., achievement, satisfaction, motivation), and the perceptions of participants toward this environment (e.g., effectiveness of PBL, collaborative affordances, benefits of Web 2.0 tool) (e.g., ChanLin & Chan, 2007; Ioannou, Vasiliou, & Zaphiris, 2016; Kay & Kletskin, 2012).

Major Findings

The findings and results of the reviewed articles were examined, and each major finding was assigned a code. Then, related codes were sorted into categories, and categories into themes. As a result, major findings of the reviewed articles were found to consist of six themes, as presented in Table 3.

Major Findings	*f*
Effectiveness of Web 2.0 technologies supporting PBL	
• Participants' perceptions of Web 2.0 tools' advantages in PBL environment	
○ Sharing (wiki)	1
○ Usefulness (video podcast)	1
○ Ease of use (video podcast)	1
○ Effective learning tools (video podcast)	1
○ Online resource (YouTube)	1
○ Collaboration	1
• Effectiveness of Web 2.0 technologies supporting PBL compared to traditional PBL	
○ Higher level of satisfaction for Web 2.0 technologies supporting PBL	2
○ Higher level of motivation for Web 2.0 technologies supporting PBL	2
○ No significant difference between groups in terms of group work	1
• Positive experiences of participants for Web 2.0 technologies supporting PBL	5
Effects of Web 2.0 technologies supporting PBL on participants' skills	
• Collaboration	6
• Communication	3
• Reflection	2
• Self-directed learning	2
• Information and communication technologies (ICT) skills	1
Effects of Web 2.0 technologies supporting PBL on participants' achievement	
• Improvement of achievement following Web 2.0 technologies supporting PBL	10
• No difference between groups (Web 2.0 technologies supporting PBL & traditional PBL)	2
Changes in satisfaction	4
Changes in attitude	1
Improvement of engagement	1

Table 3: The frequencies of major findings in the studies

According to Table 3, the most frequent finding was the effectiveness of Web 2.0 technologies supporting PBL (f = 16) (e.g., de Jong et al., 2013; Jaffar, 2012). Three categories were identified in this theme. The category of 'participants' perceptions of Web 2.0 tools' advantages in PBL environment' included sharing in a wiki environment (f = 1), the usefulness (f = 1) and ease of use (f = 1) of video podcasts, the effectiveness

of video podcasts in learning (*f* = 1), collaboration (*f* = 1) and being an online resource (e.g., YouTube) (*f* = 1). The category of 'effectiveness of Web 2.0 technologies supporting PBL compared to traditional PBL' showed participants' level of satisfaction (*f* = 2) and motivation (*f* = 2) to be higher in Web 2.0 technology-supported PBL groups. But, there was no significant difference found in terms of group work between Web 2.0 technology-supported PBL group and traditional PBL groups (*f* = 1). The final category in this theme was 'positive experiences of participants for Web 2.0 technologies supporting PBL' (*f* = 5).

Effects of Web 2.0 technologies supporting PBL on participants' skills (*f* = 15) was the second theme identified in the major findings of the reviewed articles (e.g., Moeller, Spitzer, & Spreckelsen, 2010; Williams et al., 2010). This theme included categories of collaboration (*f* = 6), communication (*f* = 3), reflection (*f* = 2), self-directed learning (*f* = 2), and ICT skills (*f* = 1) of participants which were found to have improved following the application of Web 2.0 technology-supported PBL.

Effects of Web 2.0 technologies supporting PBL on participants' achievement was the third theme identified in the major findings of the reviewed articles. In this theme, participants' level of achievement following the application of Web 2.0 technology-supported PBL was reported. Most of the studies reported that the achievement of the participants increased (*f* = 10) (e.g., Huang et al., 2016; Lo, 2009). A few studies reported no significant difference in terms of the participants' achievement between Web 2.0 technology-supported PBL groups and traditional PBL groups. Therefore, Web 2.0 technologies supporting PBL can be seen as an effective way to increase students' achievement.

Additionally, changes in participants' level of satisfaction (*f* = 4) (e.g., Ioannou et al., 2016; Lo, 2009), changes in participants' attitude (*f* = 1) (Robertson, 2008), and the improvement of participants' engagement (*f* = 1) (Gordon & Gayeski, 2013) following application of Web 2.0 technology-supported PBL were other themes identified in the major findings of the reviewed articles.

The major findings of the reviewed articles were found to be congruent to the known characteristics of problem-based learning and Web 2.0 technologies. In the literature, problem-based learning has been reported to positively affect students' achievement (Duffy & Cunningham, 1996; Hmelo-Silver, 2004), engagement (Delialioğlu, 2012; Marra, Jonassen, Palmer, & Luft, 2014), and the acquisition of 21st century skills (Hung et al., 2008; Şendağ & Odabaşı, 2009). However, technology usage within the learning environment is an important issue. According to Jonassen and Reeves (1996), technology can be used for the construction of new knowledge within the PBL environment.

Therefore, PBL and Web 2.0 technology together can enable students to become more active in the learning process. For example, students can work on ill-structured problems, collaborate with other students, search for solutions, communicate with their instructor and other students, and develop solutions. At the end of the process, Web 2.0 technologies supporting PBL has been shown to have an important effect on educational output. In this regard, Web 2.0 technologies supporting PBL environment can be considered an alternative way to increase students' course achievement, motivation, engagement, and 21st century skills acquisition.

CONCLUSION

In this study, the researcher reviewed studies published on the topic of Web 2.0 technologies supporting PBL in journals indexed as SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI, and ERIC between February 2004 and February 2018. Within this aim, 18 articles were reviewed in terms of their year of publication, research domain, research paradigm and method, utilisation of Web 2.0 tools, sample level, data collection tools, data analysis methods, dependent variables, and major findings.

The emergence of studies in this area was in 2007, and has continued to be researched through to the present day. From the 18 articles reviewed, the topic was found to have been examined in different research domains. While the qualitative research paradigm was the most frequently applied, followed by mixed method and quantitative paradigms, the case study design was the most preferred among the qualitative methods. Wiki was the most preferred Web 2.0 tool utilised within the PBL environments. When the sample level in the studies was examined, higher education students were the most studied participant group. Among the data collection tools used in the studies, interview was the most frequently used, followed by survey, achievement/performance test, discussion transcripts, e-mail messages and other records, documents, and reflection. Regarding the type of data analysis method employed, the qualitative analysis methods were mainly used parallel with the research paradigm of the study. Descriptive and inferential statistics were less frequently applied in the studies. The variables investigated most in the studies were perceptions about the effectiveness of PBL and of achievement. When the major findings of the studies were examined, the effectiveness of Web 2.0 technologies supporting PBL was the most frequently reported finding, followed by the effects of Web 2.0 technologies supporting PBL on participants' skills and achievement.

The current situation with regards to Web 2.0 technologies supporting PBL environments is drawn with these results. The following recommendations are put forward in terms of potential future research in this area:

- Empirical studies could be conducted in order to reveal the effect of Web 2.0 technologies supporting PBL environment on learners' educational development (e.g., achievement, engagement, attitude).
- Future studies could be conducted with some of the less studied sample groups, especially K-12 education level students.
- Web 2.0 technologies supporting PBL environments have mostly been designed for the field of social science and medical science. Therefore, this topic could be investigated in fields such as natural science and engineering and technology science.
- Designing an online PBL environment with free Web 2.0 tools is well worth conducting. For example, social networks, online collaborative tools, and online communication technologies could be used in order to support PBL environments in studies of the future.

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Action Research in Planning Education – Experiences from Problem-oriented Project Work at Roskilde University

Martin Severin Frandsen and John Andersen *

ABSTRACT

This article presents experiences and reflections from two cases of problem-oriented project work working with action research in bottom-up urban planning and sustainable transition in Copenhagen. The first case concerns the involvement of local residents in the redesign of a public square through a series of aesthetic experiments. The second case concerns an experiment with alternative transport solutions and sustainable street transition through reduction of private car use and the creation of new public spaces on former parking lots. The article concludes that action research seems to be a promising way of involving students in processes of planning and sustainable urban transition. Seen from the perspective of external stakeholders, the students can make valuable contributions to the exploration of the potentials of places and the possible futures of communities, and they can assist in providing a knowledge base for planned experiments and initiatives. Seen from the perspective of the students, doing action research strengthens their understanding of "the logic of practice" and their ability to master practical and ethical judgments in complex real-world empowerment and learning processes.

Keywords: Planning education, action research, sustainable transition, problem-oriented project learning (PPL), social learning, empowerment.

INTRODUCTION

In 2009, Roskilde University (RUC) launched a new program in urban planning (Plan, By & Proces/Planning Studies). The purpose of the new program was to educate planners that could supplement the traditional planning professions of the architect and engineer

* Martin Severin Frandsen, Department of People and Technology, Roskilde University
Email: martinfr@ruc.dk
John Andersen, Department of People and Technology, Roskilde University
Email: johna@ruc.dk

and on a theoretically informed basis would be able to design and facilitate interdisciplinary and participatory planning processes. From the start, action research was a core part of the curriculum and was taught in both courses and tried out in problem-oriented project work, the key element in the so-called "Roskilde University model" of problem-oriented participant-directed project learning (PPL) (Andersen & Heilesen, 2015).

Whereas there is growing body of research literature on action research in higher education, there seems to be almost no studies that directly link action research to the principles of problem-based or problem-oriented learning (Gibbs et al., 2017; Laudonia et al., 2018; Thorsen & Børsen, 2018). In this article, we will by way of two case studies of action research in problem-oriented project work explore the following research questions: What is the "added value" of doing action research in problem-based learning and problem-oriented project work? And how do we ensure that value is created for all participants in "student-directed" action research?

The criteria for the choice of cases followed Flyvbjergs strategies for information-oriented selection (Flyvbjerg, 2016, pp. 229-233). We chose two atypical cases (extreme/deviant cases in Flyvbjergs terminology). The first case was an unusually successful case that was chosen to obtain knowledge on the potentially "added value" of working with action research in problem-oriented project work and the conditions for successful collaborations between students and external partners. The second case was a more complex and problematic case that we chose to reveal some of the potential tension points and challenges in student-led action research and to discuss strategies to cope with these. The qualitative data for the case studies we collected from field notes from supervision meetings (5-6 meetings with the students per project), communications and feedback from external stakeholders and the final project reports (Nielsen, Ullerup & Fløyel, 2016; Schock et al., 2017; Dahlerup, 2018).[i]

The first part of the article outlines the key theoretical foundation of the Planning Studies (PS) program: planning as social learning and social mobilization. We highlight the affinities between participatory planning and action research and outline a model of prototypical phases in community-based action research. Secondly, we describe the Roskilde University pedagogical model of problem-oriented project learning (PPL). In the third section, we describe how we have worked with action research on Planning Studies in the framework of PPL, exemplified by the two cases of project work. Finally, we reflect on the potentials and challenges of working with action research in problem-oriented project work and draw conclusions in relation to the two research questions.

PARTICIPATORY PLANNING TRADITIONS

The civil rights movement in the US in the sixties and the upcoming urban movements and revolts fundamentally challenged the legitimacy of mainstream planning based solely on technical expert knowledge. Inspired by massive community mobilizations (Jacobs, 1961), critical planners challenged the idea of planning as a value-free activity purely based on "objective" scientific and technical knowledge. The theory and practice of advocacy and participatory planning was born. Drawing on a tradition and "canon" of progressive community activism that can be traced back to the progressive era and pragmatists like Jane Addams and John Dewey (Fisher et al., 2012), advocacy planning (Davidoff, 1965) wanted to put poor people's needs first, facilitate community empowerment and challenge the power of economic, bureaucratic and political elites at all levels. The participatory and social justice-oriented planning tradition (Marcuse, 2011) has, with varying degrees of success, struggled to create a form of planning that emphasized social justice, local needs and the empowerment of citizens.

Planning theorist John Friedman speaks of two participatory planning traditions, *social learning* and *social mobilization* (Friedmann, 1987). In brief, *social learning* is a typically bottom-up orientated form of planning where planners, community workers, citizens and other stakeholders collaborate in common problem solving and mutual learning processes (Frandsen, 2018). Through these learning processes, the capacity for collective problem solving is strengthened while the involved actors learn about themselves and their community. *Social mobilization* is a form of planning based on people's empowerment in social movements with a transformative potential to create more socially just development paths in society (Andersen, 2007). Citizens are here seen as (potentially) empowered collective agents that can 'take back the future'.

PARTICIPATORY PLANNING AND ACTION RESEARCH

The kind of knowledge production that is characteristic of the critical planning traditions is closely related to the participatory knowledge creation that characterizes the action research tradition. Action research facilitates collective action and change while at the same time producing new knowledge. Action researchers see themselves as co-producers of knowledge together with social actors struggling for social justice and people's empowerment: they share a commitment to democratic change (Brydon-Miller & Aragón, 2018).

Social learning-orientated planning has traits in common with Pragmatic Action Research, where the aim is to support social inquiry and problem solving (Greenwood & Levin, 2007; Frandsen, 2016), and it also bears resemblance to the Critical Utopian

Action Research-tradition (CUAR) that has a strong focus on the creation of 'free spaces' and social experiments (Gunnarsson et al., 2016; Egmose, 2015). Planning as social mobilization has strong ties to both the North American (Brydon-Miller, 1997) and the Latin American Participatory Action Research (PAR) traditions (Fals Borda, 2001; Azril, 2018).

In the following, we shall briefly outline a simple heuristic and prototypical model for phases in participatory and community-based action research, drawing upon the sources and action research approaches mentioned above (see figure 1). In other words, we draw upon several traditions and concepts of action research – action research as empowerment facilitation (Andersen, 2007), action research as experimental and social learning (Frandsen, 2018), action research as social innovation (Moulaert et. al., 2013) and the work of Brydon-Miller & Aragón (2018) on the multiple roles of action researchers – from participatory inquiry to advocacy vis-à-vis authorities, trust building, etc.

The starting point is social tensions, everyday troubles and social injustices where some kind of collective action is needed to break away from, to find solutions to or to better cope with the situation. The first phase in the action research process is to make contact and engage in dialogue with the relevant actors and citizens affected by the situation in order to identify possible partners in an action research collaboration based on a joint understanding of the problem(s) that can guide further inquiry.

If this phase works out successfully, the next phase can be a deeper participatory inquiry of the problem and its context, where the creation of contextualized knowledge is linked directly to trust building, awareness raising and development of mutual commitment (horizontal empowerment) in relation to citizens and local stakeholders. Based on this deeper and contextualized understanding, the next step is to jointly create suggestions for collective action and problem solutions with a broader group of citizens and stakeholders. In the following phase, an action committee or coalition (partnership) of actors either with their own resources and/or with support from private foundations or public funds can engage in an experimental test of the problem solution. If the problem solution requires changes at the political level, e.g. changes in legal regulations, public funding, etc., the knowledge and arguments for the problem solution can be advocated in the public and political sphere (vertical empowerment). If the problem solution improves the situation the initial everyday troubles and social conflicts will be reduced.

The final step can be to "upscale" the knowledge, ideas, practical capacity building, narratives, etc. to other communities, organizations and to higher levels: regional, national and transnational levels. If experimentation fails due to opposition or obstruction from political or private actors (e.g. investors and property owners), this knowledge about structural obstacles for progressive change can be shared to the wider public to stimulate

deliberation about transformative empowerment and changing opportunity structures promoting more social justice in society.

In other words, if action research fails in the first round, it does not mean that it is useless. Both less successful experiments or experiments blocked by political and economic elites can be useful for reflection, narratives and deliberation in similar problem contexts. In other words, the learning process in action research consists of both successes and failures (Greenwood & Levin, 2007, p. 109-113).

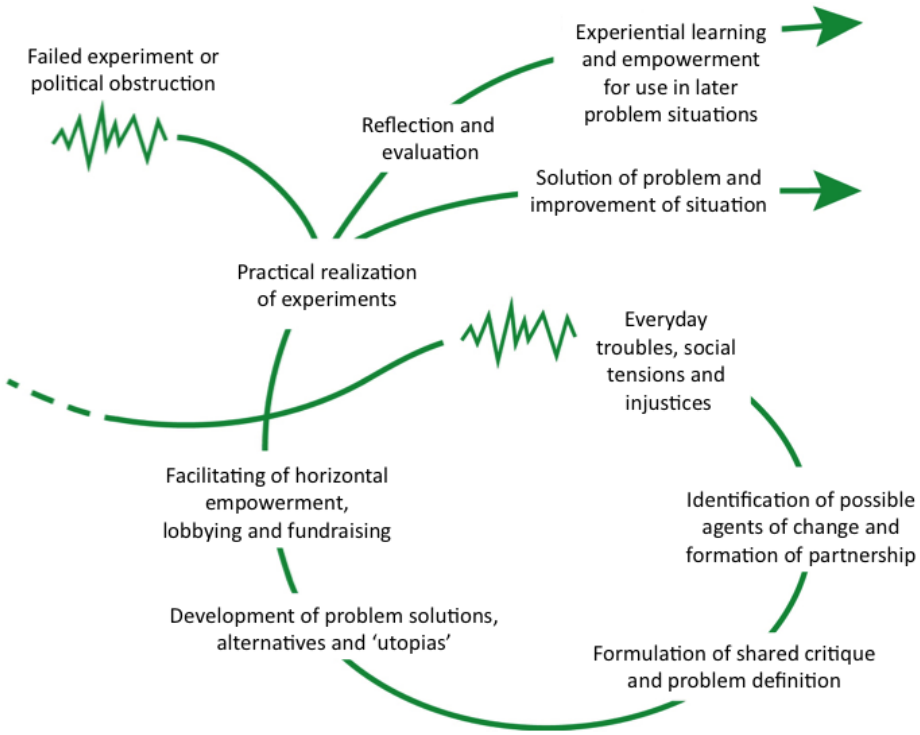

Figure 1: Prototypical phases in community-based action research. Adapted from Frandsen, 2016

As stated before: the above is a prototypical model. As the experienced American (North and South) action researchers Brydon-Miller and Aragón argue, the conditions for action research are extremely dependent on the political, institutional and socio-cultural context, which shapes the way in which the various stages of the action research process can be played out in practice.

"In some cases, the community may be well-established, and […] the process can be focused on bringing the researcher into an existing set of relationships. In other cases, […] more time must be spent in […] building relationships within the community […] Some communities are extremely hierarchical requiring the researcher to negotiate and sometimes challenge systems of power […] while in other cases the lack of any hierarchy at all or any authority makes it difficult to establish communication and to assign responsibility for carrying out tasks. And finally, in some cases communities may be so

divided that nothing can be accomplished until lines of communication and basic trust have been established" (Brydon-Miller & Aragón, 2018, pp. 35-36).

In many cases there will be iteration where the same phases (e.g. problem identification or (re)design of solution strategies) are reworked and repeated again.[ii]

PROBLEM-ORIENTED PROJECT LEARNING (PPL)

The pedagogical model at RUC is based on problem-oriented participant directed project learning (PPL) (Andersen & Heilesen, 2015; RUC, 2017). In practice, this means that 50 pct. of the students' work is dedicated to project work while the remaining 50 pct. consist of courses in different forms, ranging from traditional lectures to experimental workshops. The PPL-model in its original form in the 1970s was strongly influenced by the critical pedagogical ideas of student movements emerging in the late 1960s and the idea that higher education should promote "dual qualification":

"*Firstly, it should provide suitable academic and professional qualifications for today's society, including those of an innovative and creative nature. Secondly, higher education should help students to develop critical judgement, enhance their societal involvement, and increase social equality and justice"* (Andersen & Kjeldsen, 2015a, p. 5).

Although the interpretation of the PPL-model has evolved over time due to changing circumstances and the influence of new pedagogical ideas, most of principles of the original model still exist. The key principles as they are interpreted today are as follows:

1. *Project work*. Project work entails extended work on a well-defined problem and area of study within a given time frame of typically 4 months. At RUC, project work is organized in groups of two or more students. The students control the process under supervision and seek out and evaluate which theories and methods to use by themselves. Project work is based on the model of scientific investigation and inquiry. Students do projects that are similar to the ways in which researchers conduct research projects (Andersen & Heilesen, 2015, p. xi; RUC, 2017).

2. *Problem-orientation*. Project work is problem-oriented. The point of departure for choosing and determining a problem is what Andersen & Kjeldsen term "*the trinity of personal, study-related and societal relevance*" (Andersen & Kjeldsen, 2015b, pp. 24-25). The criterion of personal relevance ensures motivation and engagement, the criterion of study-related relevance ensures that the studies correspond to the curricular requirements, and the criterion of social relevance ensures that the studies are oriented towards existing and real-world social problems. Problem-orientation will thus often be driven by cooperation with stakeholders in society outside the university (RUC, 2017).

3. *Interdisciplinarity*. Problem-orientation is linked to interdisciplinarity. It is the problem of a project rather than a traditional discipline that determines the choice of theories and methods. The interdisciplinary dynamics arise through analysis of complex problems that require solutions across subjects and research approaches (Andersen & Heilesen, 2015, p. xi; RUC, 2017).

4. *Participant control*. Participant-directed learning is manifested in the students' choice of problems and in their own control of the project work under guidance from a supervisor. The terms participant control and participant-directed learning are preferred to the term student-directed learning firstly because project work is supervised by a teacher, and secondly, because projects have to conform to the curricular framework (Andersen & Heilesen, 2015, p. xii; RUC, 2017). To this, we would add that in cases where there is cooperation with stakeholders outside the university, like in action research processes, these collaborators act as a third kind of participant. Finally, with regard to courses, the learning process is more structured according to the subject and is largely determined by the lecturers (RUC, 2017).

5. *Exemplarity*. Exemplarity means that an example or case is studied in such a way that it develops the students' insights into and overview of the investigative practices, methods and theories of the academic fields in question (RUC, 2017). Exemplarity can also mean that the content of project work should be related to and seen as exemplary of broader social and public issues, and that the examples the students choose can be related to their own experience and as well as to the social conditions that influence their experiences (Andersen & Kjeldsen, 2015b, p. 25-27).

6. *Group work*. Project work is conducted in groups, and group work is also used in courses or workshops ranging from, for example, reading groups to smaller group exercises and "mini-projects". The main arguments for group work are that it promotes individual and collective cognitive processes and development, that it can illustrate a problem more comprehensively and more in-depth than the individual student can achieve alone, and that the academic discussions within the group establishes a mutual learning process (RUC, 2017).

It is evident that the PPL-model shares basic pedagogical principles with the variety of approaches that constitute PBL (Savin-Baden & Major, 2004). One of characteristics of PPL is that the emphasis on the students' participation in the formulation of problems is particularly strong (Andersen & Kjeldsen, 2015a, p. 14). This key element can be traced back to the early formulation of PPL in the writings of Knud Illeris. According to Illeris, a problem is a problem in the psychological sense only if it is formulated and chosen by the person who has to work with it:

"*If the solution, or at least the elucidation of the problem, does not appear as a personal challenge, the conditions for accommodative learning are not present and thus neither*

the conditions for the development of creativity and flexibility (…) Accommodative learning is a demanding process that requires commitment. You accommodate only in situations that are relevant to yourself and what you are doing (Illeris in Andersen & Kjeldsen, 2015a, p. 7-8).

Students, however, have to argue for the relevance of the problem they choose to work with according to the trinity of personal, study-related and societal relevance as described above. At the same time, students in many cases start out from project ideas or suggestions proposed by supervisors or external stakeholders. In these cases, "… *it is crucial that the proposals from the supervisor [or external stakeholder] are very brief so that the students can personalize the idea and make their own investigations and reflections in order to formulate a genuine problem for the project*" (Blomhøj et al, 2015, p. 99).

ACTION RESEARCH IN PLANNING STUDIES

The relatively extensive time frame of project work at RUC of typically 4 months, together with the principles of problem-orientation and participant control, provides a distinct opportunity structure for doing action research with stakeholders outside the university, which to some extent makes it possible to escape from some of the institutional challenges for action research in contemporary universities (Thorsen & Børsen, 2018, p. 192) and from what Greenwood terms "academic Taylorism" (Greenwood, 2012, p. 119).

In the Planning Studies-program we have taught action research in courses and promoted action research in project work by facilitating "matchmaking" with external partners through meetings at the start of each semester where stakeholders – ranging from NGO's, community activists, social housing associations to municipal planning departments – present ideas for possible cooperation.

ACTION RESEARCH IN COURSES

Teaching students action research within the framework of courses can be seen as a preparation for working more independently with action research in project work. The PS courses introduce the historical roots and principles of action research, present concrete cases of action research in cities and communities conducted with various stakeholders, i.e. community development projects, local councils, activist groups and "ordinary citizens", and provides a framework for the students to try out action research in "mini-projects".

In PS we have experimented with different activities that are often located in urban or rural neighborhoods outside university walls. It is one thing to lecture on the epistemology and methodology of action research – it is another thing to develop the multiple "hands on" skills required to practice action research (Brydon-Miller & Aragón, 2018). This requires experiential learning processes with "live cases". It is our (and the students) clear judgment that placing courses *on location* makes a big difference (Rask and Andersen, 2016). It gives a completely different feeling to be in the thick of things, and it creates the possibility to organize city walks, mapping exercises, informal interviews on the streets and for relationship building and dialogues with local stakeholders and citizens.

The aim of the courses are to show, *in germ form*, how action research can contribute to empowerment and learning among citizens and produce input and proposals for planning that is based on local needs. Through "mini-projects", students are trained to analyze development plans for the neighborhood, to design and use different methods for citizen involvement and community mapping, to conduct interviews with local stakeholders and to develop and sometimes realize small scale initiatives and plans of their own. All of it to identify local needs and facilitate a shared problem definition among local citizens and stakeholders, to formulate proposals and visions for local planning and to develop the capacity to realize these.

ACTION RESEARCH IN PROBLEM-ORIENTATED PROJECT WORK – POTENTIALS AND CHALLENGES

To a large extent, problem-orientated project work provides an ideal framework for working with action research within planning education. The starting point for project work is typically concrete and practical public planning issues and, in comparison with the courses, the time frame is longer, with projects running for 4-5 months from the project's inception to its conclusion.

Working with action research in project work is, however, still somewhat of a balancing act. Even though the time frame is relatively long compared to the time allowed for in courses, it is still a short time frame in comparison with the time frame that characterizes a "real" action research project, where the researcher often engages in longer running collaborations that sometimes go on for several years. There is therefore a risk that the collaboration becomes a frustrating experience for both students and external stakeholders, entailing what Thorsen and Børsen term a "breach of expectation" (Thorsen & Børsen, 2018, p. 185) because the hopes for realizing an action or experiment that is valuable for both the students and the external stakeholder are not met.

Case 1: Aesthetic experiments

In the following, we will outline an example of successful action research collaboration between a group of students from PS and an external partner in the form of a so-called "area renewal project", *Områdefornyelsen Indre Nørrebro*, in the inner-city neighborhood of Nørrebro in Copenhagen. "Area renewal" is a 5-year integrated urban renewal program targeted at disadvantaged neighborhoods and housing areas. The integrated area renewal project was launched in 2014 in the inner part of Nørrebro, which underwent a prior urban renewal effort in the 1980s where many buildings, including tenements, were torn down. The renewal project in the 1980s was met with strong protests from local residents and sometimes led to violent conflict. Many of the new urban spaces that were created have subsequently shown not to be accommodating spaces for the social life of the neighborhood. To make up for the errors of the past, the current area renewal project aims at involving local citizens in the redesign and improvement of a number of the central squares and spaces in the neighborhood.

Experiences from earlier recent area renewal projects had shown that collaboration with student groups could sometimes be time demanding, and the investment from the planners in the urban renewal project did not always yield a return in the form of valuable knowledge once the student groups had completed their project. Sometimes, students forgot to report their findings in an accessible way to the external partners once they had finished their exams and had moved on to the next project. In other cases, the students were seen as having a poor understanding of "the logic of practice" in a real-world context and their analysis, evaluations and judgments seemed to rest on very idealistic assumptions about planning with little value as practical guidance.

To make better use of the work of the students, the new area renewal project developed a practice of involving student groups in experimental test phases in the redesign of the local squares and urban spaces. The students, through experiments with smaller workshops, design-prototypes and events, could map out and explore the potentials for future development before the area renewal project itself began the more permanent redesign and renewal process. Seen from the Planning Studies' and the students' perspective, the advantages of this type of partnership was that the area renewal project – in exchange for the practical experimentations of the students – made a lot of resources available in the form of local knowledge and gate keepers, that helped to make action research possible within the time allowed for to do project work.

After themselves making contact with and consulting the area renewal project, a group of students doing their master's thesis chose to work with the renewal of a small local square named after the local and still existing social settlement "Askovgården". The theoretical and methodological starting point was a combination of diversity planning (Sandercock, 2004) and arts-based action research (Brydon-Miller et al., 2011). From this starting point, the students drew the hypothesis that artistic and aesthetic methods held particular

potentials to engage a diverse group of residents, because aesthetic impressions and experiences speak to both emotions and to the imagination and communicate in a direct way to the everyday life of citizens (Nielsen, Ullerup & Fløyel, 2016. pp. 9ff).

To test this hypothesis, the group designed a series of 4 aesthetic experiments with new forms, colors and materials and sought to engage local residents and organizations in all phases of the process. The whole process ran for 2.5 months and was divided into three different phases: a prelude, realization of 4 aesthetic experiments and an evaluation.

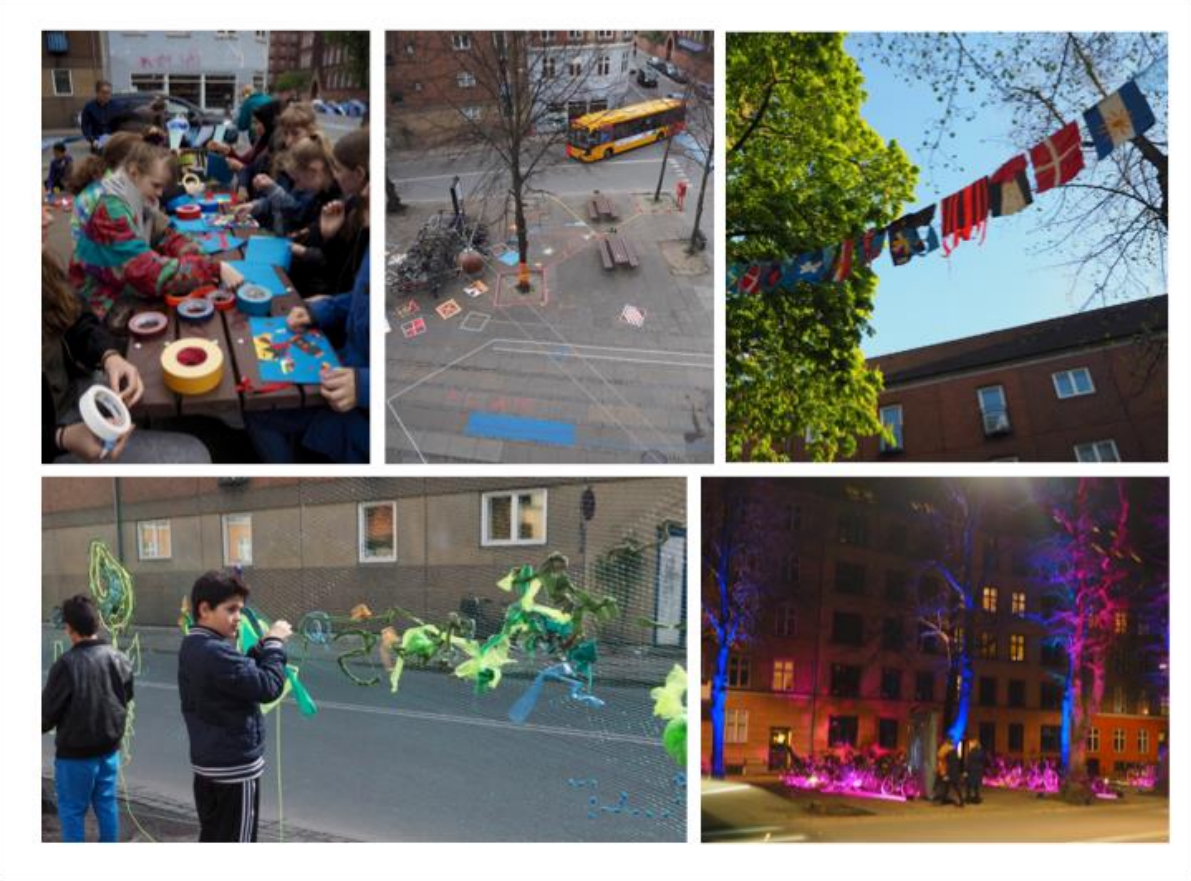

Figure 2: Impressions form the 4 aesthetic experiments. Clockwise from left to corner: Children creating flags in the experiment Sky Space, street patterns made from colored tape form the experiment layouts, flags from the experiment Sky Space, decorated wire from the experiment Spaces in The Space and light installation from the experiment Lightning (Photos: A. K. Nielsen, S. B. Ullerup & S. Fløyel)

Although several obstacles were encountered on the way, the experiences from the experiments to a large extent confirmed the students' guiding hypothesis. Already the first aesthetic experiment showed that it did not take much more than a couple of people and a pile of colored tape to engage a diverse group of citizens and change their image of what is possible in a given place. The activities that took place while the experiments unfolded drew people's attention and a broad group of people involved themselves out of curiosity and joy. The aesthetic experiments created a space where a diverse group of

citizens could express themselves physically and practically and not only through words. They created an "aesthetic free space" on the square, where citizens on their own terms could get involved and develop and try out alternatives. The process became the focal point of *"a learning process at both an individual, social and cultural level, whereby participants [could] gain new perspectives on themselves, each other and the ordinary everyday life at Askovgårdens Plads"* (Nielsen, Ullerup & Fløyel, 2016, p. 78).

Case 2: Sustainable street transition – from parking lots to community space

The second case of action research in problem-oriented project work concerns an experiment with sustainable transition in the local street Badensgade in the neighborhood of Amagerbro also in central Copenhagen. In contrast to the publicly led urban renewal project on Nørrebro, the initiative on Amagerbro was civil society-based and the project was more loosely tied to the municipal planning authorities.

The goal of the project was firstly to explore how the amount of privately-owned cars in the inner city could be reduced, and how the space now reserved for parking could be used for social and community activities. Secondly, the goal was to investigate how local residents themselves could lead a sustainable transition and transform and manage urban spaces. To achieve these goals, the experiment involved two logically linked subprojects: The first subproject aimed at reducing the local dependency on private cars through locally based initiatives like carpooling, introduction of a local bicycle library, arrangement of delivery services with local shops, free advice on sustainable transport solutions, etc. The idea behind the second subproject was to involve the local residents in the design and co-creation of temporary and mobile urban furniture for community activities to explore the possibilities for future use of the space potentially freed from car parking.

Two aspects of the experiment on Amagerbro made it more complex and potentially conflictual than the renewal project on Nørrebro. The resident-led approach and the loose ties to the municipality made the collaboration with the planning authorities more difficult, and it meant that the experiment ran into more obstructions. At the same time, the potential removal of local parking spaces – creating less favorable conditions for private car ownership – was a potential subject of controversy internally among the residents. These difficulties also complicated the situation for the student project groups doing action research in partnership with the local stakeholders.

The project was initiated by the homeowner association in Badensgade together with architect and urbanist Henrik Valeur, who had a long record with participatory planning locally and internationally (Valeur, 2014). Valeur had been looking for a neighborhood in Copenhagen that was willing to take part in experiments, where the aim was to reduce car use dependency and to redesign public places. The connection to Badensgade was made with the help of the local center for environment (Miljøpunkt Amager) and the local

district council (Amager Øst lokaludvalg). The project was presented to the residents on a general assembly in the homeowners' association in May 2017, where Valeur received support to carry on with the project (Schock et al., 2017, p. 15). Following the meeting, Valeur and the board were successful in obtaining initial funds from the municipality for a pilot study to develop the project and later from the Danish Arts Foundation for the actual realization of parts of the experiment.

As part of the pilot study, alongside with developing the project brief, organizing a workshop for the residents, etc., Valeur contacted Roskilde University and Planning Studies with the aim of establishing partnerships with student project groups that could support the development and practical realization of the experiment. The experiment was presented for the students as part of the start of term activities and in the following year, first a project group on master's level, and later a thesis student, collaborated with the project (Schock et al, 2017; Dahlerup, 2018).

The contribution of the first project group was tied to the pilot study and the development of a knowledge base for the experiment. The focus of the project was to investigate the mobility habits of the local residents and to inquire into their views and perspectives on the development of alternative transport solutions and transformation of the street. The group conducted 68 short interviews with residents followed by a focus group with 6 residents (Schock et al., 2017, pp. 26- 38).

Whereas in the previously described case on Nørrebro there had been little contact and communication between the university supervisor and the external stakeholder and partner, the collaboration with the first project group showed that the more complex and potentially controversial project on Amager demanded a closer collaboration and alignment between the student group, the supervisor and the external action research partner to make sure the student project would contribute positively to the experiment. As mentioned, the potential removal of parking spaces was a "touchy" subject among the local residents that had to be dealt with delicately. This meant that the aim and purpose of the experiment had to be communicated carefully to the local residents to prevent misunderstandings that could potentially create local opposition. The actions and interventions of the student group thus to a larger extent needed to be co-designed in collaboration between the students, the supervisor and the external partner.

A further complication for the action research partnership occurred when the Badensgade-project reached the planned phase of realization in the spring of 2018. As mentioned, the idea behind the second subproject was to design temporary and mobile urban furniture in the space potentially freed from car parking – in other words, this meant occupying parking space on the road surface.

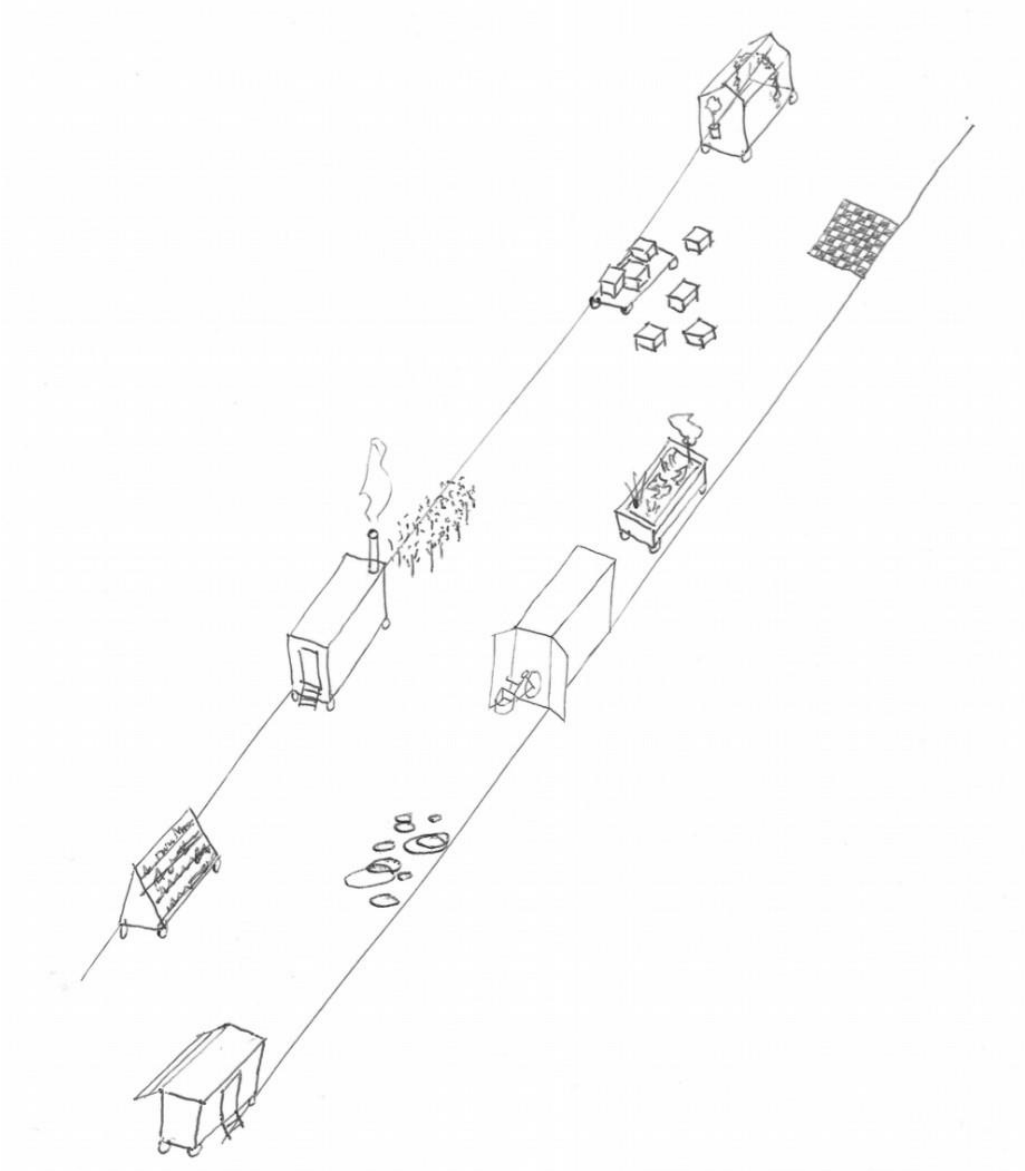

Figure 3: Sketch of planned furniture and installations. Sketch: Henrik Valeur.

The 320-meter long street of Badensgade has a legal status of "private community road", which means that the homeowners' association holds a certain authority over the street. However, they must comply with requirements for technically sound facilities, and they must ensure that the road is in good and proper condition and that private dispositions do not violate public planning and safety measures (Schock et al., 2017, p. 12). Although the temporary occupation of parking spaces was approved by the general assembly in the homeowners' association, the approval from the municipal planning authorities proved to be a much more complex and complicated affair due to the technical and safety issues involved in using the spaces on the actual road – and not just the pavement. As a consequence, the experiment had to be postponed for an indefinite period and most of the experiments planned for the summer of 2018 had to be canceled. This situation also

caused complications for the master's thesis student who was collaborating with the project at the planned stage of realization. Whereas the initial idea behind the action research collaboration was that the student should contribute to the practical experimentations, the thesis project had to be re-orientated to focus more on uncovering the obstacles and difficulties for citizen-led bottom-up planning initiatives (Dahlerup, 2018).

Although most of the activities planned for the summer of 2018 had to be postponed, one activity was realized in the form of a prototype of the intended temporary and mobile urban furniture for community activities – without the official permission of the authorities.

Figure 4: Co-creation of street furniture. Photo: Henrik Valeur.

CONCLUDING REFLECTIONS

In conclusion, we will propose some answers to the two research questions on the basis of the case studies. Firstly, we asked: "How we can ensure that value is created for all participants in "student-directed" action research and project work?" The case studies indicate that collaborations work out best when local stakeholders and gatekeepers have

clearly defined needs and a commitment to collective action, while at the same time being open for meeting the students personal and academic motivations. Collaboration with students in experimental test phases or pilot projects seems to be a promising way of involving students in processes of planning and sustainable urban transition. Seen from the perspective of the external stakeholders, the students can contribute with valuable insights in the exploration of the potentials of places and the possible futures of communities, and they can also assist in providing a knowledge base for planned experiments and planning initiatives. In exchange, the students, from their perspective, are offered proposals for projects of societal relevance that they can choose from and personalize, and they are also given access to local knowledge and gatekeepers that can help to make smaller action research projects possible within the time frame of project work.

In some cases, like the project on aesthetic experiments in Inner Nørrebro, the students can make contact with and create partnerships with external stakeholders with little facilitation from the university**.** In other and more complex cases where the potential for conflict is greater, like the case in Badensgade on Amager, alignment of interests, approaches and methods between students, supervisors and external stakeholders needs to be facilitated more in depth, as tensions between students and external stakeholders can occur in the process.

In most cases there are also tensions between the requirements of the action research work and the annual cycle and timetable of academia. Our conclusion here is in line with Pain et al. (2006), who state that coping with these "productive tensions" is a condition for following an action research orientation. Successful collaborations thus depend on close and flexible supervision of the students in order to make sure that the cooperation with the external partners can work and that the students can meet the requirements and time schedules given by the study program.

Secondly, we asked: "What is the "added value" of doing action research in problem-based learning and problem-oriented project work?" Our overall assessment from the case studies is that action research based on project work in local neighborhoods is a powerful tool for "double qualification" and education of engaged participatory planners. The huge potential with regard to learning outcomes is that students can complement academic skills with skills to engage and navigate in complex non-university contexts with different (and in some cases) potentially conflicting stakeholders. Students can develop a better understanding of "the logic of practice" and acquire the ability to master practical and ethical judgements in complex "real life" empowerment and learning processes. In relation to the goal of double qualification, this both prepares them for professional practice and provides them with an "embodied" and pragmatically empowered critical understanding of how processes of change and transformations towards a more sustainable and just society can be brought about.

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[ii] The model was developed for the purpose of this article and was thus not drawn on by the students in the two case studies.

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A Holistic and Multifaceted Model for Ill-Structured Experiential Problem-Based Learning: Enhancing Student Critical Thinking and Communication Skills

Karen Miner-Romanoff, Amy Rae and Chris E. Zakrzewski *

ABSTRACT

Educators have observed that our college graduates are not equipped with the complex problem-solving skills to contribute to the many challenges of industry and other professional contexts. This paper describes an experiential problem-based multifaceted instructional design and teaching model at the New York University School of Professional Studies, developed by instructional design and technological experts. The model combines traditional instructional design, evidence-based strategies, and learning theories for development of student critical thinkers who can transfer their new knowledge and capabilities to industry and various other professional contexts. This model includes unique faculty and student orientations and guides, students as active contributors, instructors as facilitators, and collaborative projects. Student surveys of four cohorts (68 students) over four academic quarters indicated strong positive results. Students practiced through experiential problem-based learning and thereby learned critical and creative thinking that increased their communication skills. The program, to continue through New York University, can also be adapted for professionally-oriented education degrees, certifications, and lifelong learning courses.

INTRODUCTION

In the United States, much debate has taken place about whether our graduates are properly equipped with the needed complex problem-solving skills and knowledge to succeed in and contribute to today's industry. For many, the answer is that they are not (Hora, 2016; Mourshed, Farrell, & Barton, 2013; National Association of College and Employers, 2019). In 2013, JP Morgan reported that 33% of business leaders agreed that

* Karen Miner-Romanoff, New York University
Email: romanoff11@gmail.com
Amy Rae, New York University
Email: ar5498@nyu.edu
Chris E. Zakrzewski, New York University
Email: cez2@nyu.edu

college graduates lack the critical and strategic thinking skills needed to add to the knowledge economy. Moreover, many students reported that experiential learning and industry experience are very important to their learning (Chavan, 2011).

Further, through a series of industry forums, Japanese professionals explained that their industries needed graduates with advanced problem-solving and thinking skills (Miner-Romanoff, 2017). The Job Outlook 2019 survey of the National Association of College and Employers (2019) indicated that the highest rated competency was critical thinking/problem solving skills. This competency had been the highest rated for the past 2 years.

According to a report by the Association of American Colleges and Universities (2013), only 42% of employers felt that graduates were adequately prepared for the job market. Of the employers surveyed, 93% agreed that "a candidate's demonstrated capacity to think critically, communicate clearly, and solve complex problems is more important than their undergraduate major" (p. 1). In this report, more than three in four employers said they wanted colleges to place more emphasis on helping students develop five key learning outcomes, including critical thinking, complex problem solving, written and oral communication, and applied knowledge in real-world settings.

Futurists recognize the need for greater thinking and conceptualizing skills. In extraordinary acceleration of Buckminster Fuller's "knowledge doubling curve" of knowledge every 12-13 months, IBM predicted that by 2020, especially because of the Internet, knowledge will double every 11-12 hours (Rosenberg, 2017). In *Future Shock*, Alvin Toffler (1970) famously predicted that "Tomorrow's illiterate will not be the man who can't read; he will be the man who has not learned how to learn." Toffler also suggested, "By instructing students how to learn, unlearn and relearn, a powerful new dimension can be added to education" (p. 211).

Drucker (1985/2014) observed that "what individuals have learned by age twenty-one will begin to become obsolete five to ten years later and will have to be replaced—or at least refurbished—by new learning, new skills, new knowledge" (p. 280). And Bass (2012) recognized the turning toward the higher cognitive and critical thinking skills in the disruption of traditional educational strategies and goals:

> [W]e are coming to value explicitly and systemically these outcomes of higher education--dimensions such as making discerning judgements based on practical reasoning, acting reflectively, taking risks, engaging in civil if difficult discourse, and proceeding with confidence in the face of uncertainty. (p. 7)

With such observations in mind, it is obvious that educators recognize the need for more effective teaching and learning models. Goodyear (2015) observed that "teachers' planning needs to take on more of the qualities of *design for learning*" (p. 28). Problem-based learning (PBL), rather than the traditional model of project-based learning—teacher-imparted knowledge and student-demonstrated understanding of that knowledge—has become more accepted and prevalent in academia globally and is learner-centered, fosters their sense of responsibility, increases and increases content learning as well as their cognitive and communication skills (Dischino, DeLaura, Donnelly, Massa, & Hanes, 2011; Saleh, Baker, & Al Barghuthi, 2017; Savery, 2006). In recognition of the demand and advantages of PBL, a Chair in Problem-Based Learning was established by UNESCO. The aim is to create a global society for researchers and academic staff working with PBL in PBL projects; that require real practice and real issues; are mainly sourced from industry and reflects positively on the students as it will give them opportunity to interact and team work in lookalike job environment and scenarios. (Saleh et al., 2017, p. 283)

THE NEED FOR INSTRUCTIONAL DESIGN

Research also indicates that we can increase student learning through development and implementation of instructional design theories and processes. These outcomes require the commitment of both instructional designers and subject matter faculty (Saleh et al., 2017; Twigg, 2003). Instructional design may be defined as "the systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information, resources, and evaluation" (Smith & Ragan, 2005, p. 4).

Since design models often parallel scientific models, it is assumed that most models have great empirical support. Yet, as Richey and Klein (2014) reported, "historically there has been a scarcity of research on our models, products, and tools" (p. 141). Nor are there sound instructional design models that provide depth and breadth toward identifying crucial and mediating relationships in curricular design practice and implementation. Moreover, a need exists for research that focuses on instructional design within educational settings, rather than theoretical and scientific scenarios (Goodyear, 2015; Hmelo-Silver & Eberbach, 2012), although exploration of learner-centered education has recently accelerated (Reigeluth, Beatty, & Myers, 2017a).

Although much research addresses instructional design and the learning sciences, little guidance has been offered on optimal relationships between ID teams (IDs) and subject matter experts (SME) (Pan, Deets, Phillips, & Cornell, 2003). These relationships involve negotiation of expectations in respect to strategic roles (Collins & Stevens, 2013). The lack of clarity and understanding may lead to inefficiency, ineffectiveness, and frustration for instructional designers and subject matter faculty alike (Fyle, Moseley, & Hayes, 2012), which can then result in less than optimal instructional practices and learning. To counteract such deficiencies, a major aim of this longitudinal project is to measure and analyze the iterative cooperation, communication, and collaboration between IDs and SMEs.

Current research regarding educational design embraces the real-world complexities and an iterative "development of solutions to practical and complex educational problems" within the context of empirical investigation (McKenney & Reeves, 2013, p. 99). While embracing complexity, educational design research does not attempt to remove or cleanse variation, but to provide "usable knowledge" for contexts that assume variability (Lagemann, 2002). As many design researchers have explained, this knowledge leads to methodologically creative studies conducted in authentic settings (Fishman, Penuel, Allen, Cheng, & Sabelli, 2013; McKenney & Reeves, 2013) and includes designers' abstracted experience and reflections about their designs (Fishman, Peneul, Allen, & Cheng, 2013; Kali, 2008).

During our design forums, we engaged in this type of iterative reflective design and will continue to do so. Similarly, while design research and theoretical modeling have been conducted for decades, very few studies have addressed how instructional designers apply theories and models (Mosely, Wright, & Wrigley, 2018). Further, the current limited number of studies indicate that instructional designers do not spend much time applying rigid models but may creatively utilize them to generally inform their varied and multivariate work (Kenny, Zhang, Schwier, & Campbell, 2005).

Few holistic teaching and design models have been developed with evidence-based theoretical and pedagogical approaches combined and evaluated in one approach to overcome traditional pedagogical weaknesses and biases (Reigeluth, Beatty, & Myers, 2017b). In addition, learner-centered pedagogical approaches that foster students' critical and creative thinking skills are especially needed to meet the demands of industry today (Bernold, 2005; Saleh et al., 2017). It was with this need in mind that this new instructional design and teaching model was created. The model was created to increase students' problem-solving skills, in addition to knowledge acquisition, and to meet today's global industry demands.

THEORETICAL GROUNDING

As Middleton, Gorand, Taylor, and Banna-Ritland (2014) noted, unless the explicit framework and theoretical basis upon which the design is explained, little can be added to the body of knowledge about the validity of the design. It can be emulated in its entirely or unpacked and utilized in small parts. We started with two primary theories: experiential and problem-based, with a focused review of the research (Furman & Sibthorp, 2013; Hung, 2013; Kolb & Kolb, 2009; "Problem-Based Learning," 2001; Savery, 2006).

The ancient Chinese Confucian philosopher Xun Kuang (2019) said, "Tell me and I forget, teach me and I may remember, involve me and I learn" (erroneously often attributed to Ben Franklin). This dictum is the essence of experiential learning. In experiential theory, six basic principles hold: (a) learning is a process not an outcome; (b) learning best takes place by drawing on students' prior beliefs and opinions about a topic, examined and integrated with new ideas; (c) learning requires resolving conflicts and differences in terms of existing and new ideas and reflection; (d) learning is holistic, involving the entire person, and requires adaptation in terms of problem-solving, creativity, and decisions. (e) learning requires consistent, stable transactions between person and environment; (f) learning creates new knowledge, both personal and social, in contrast to traditional modes in which previous knowledge is imparted to be absorbed (Kolb & Kolb, 2006).

Problem-based learning was introduced in the late 1960s at McMaster University Medical School in Canada, is based on Deweyan pedagogical principles, and has gained popularity in the sciences and education in the last several decades as a teaching approach (David, 2014; Guze, 2015; Ungaretti, Thompson, Miller, & Peterson, 2015). Although not without its critics (e.g., Colliver, 2000), problem-based learning has been defended convincingly as a relevant and viable pedagogical approach (De Graaff & Kolmos, 2003; Norman & Schmidt, 2000; Savery, 2019).

Many attempts have been made to define problem-based theory. The attributes approach includes learner-centered learning, addressing of real-world problems, students working in small groups, and teacher as facilitator rather than knowledge dispenser (David, 2014; Krauss & Boss, 2013). Another approach is Savin-Baden's principles: the perception of knowledge, learning, problems, students, teacher roles, and assessment (as cited in De Graaff & Kolmos, 2003). Other theoretical explanations refer to learning theory principles and combinations of PBL and traditional methods (De Graaff & Kolmos, 2003).

Advantages are students' development of critical thinking, application of knowledge and creativity to real-world problems, development of leadership and communication skills, and students' higher motivation than with traditional teaching methods (David, 2014; De Graaff & Kolmos, 2003). Disadvantages may be teachers' unwillingness to relinquish control, few or no traditional grades and tests, shifting standards, students' discomfort working in teams, students' possible faulty judgment as to what is important to learning and application, and students' lack of perceiving broader perspectives of the problem (David, 2014; De Graff & Kolmos, 2003; Reigeluth et al., 2017a).

GENESIS OF THE PROJECT

The project was facilitated by the School of Professional Studies at New York University's Center of Academic Excellence and Support (CAES) and over 30 New York City industry experts, with input from Japanese industry professionals. The team included instructional designers, educational technologists, media specialists, content experts and administrators**.** The task was to design, develop, implement, and evaluate a suite of programs for global professionals across multiple industries and sectors.

Given the advantages and drawbacks of PBL, we set out to create the most effective and innovative educational experiences with the fewest constraints. Our goal was to develop critical thinkers and complex problem-solvers who can significantly contribute to the knowledge economy in an Asian country where passive learning was still the norm. Fifteen distinct disciplines were identified, and we set out with a white board, knowledge of learning and design theories and principles, pedagogical strategies, educational technology opportunities, an assessment of our learners, and courage to take an educated and theory-grounded risk. After many hours and conferences, a working flowchart was developed (see Figure 1).

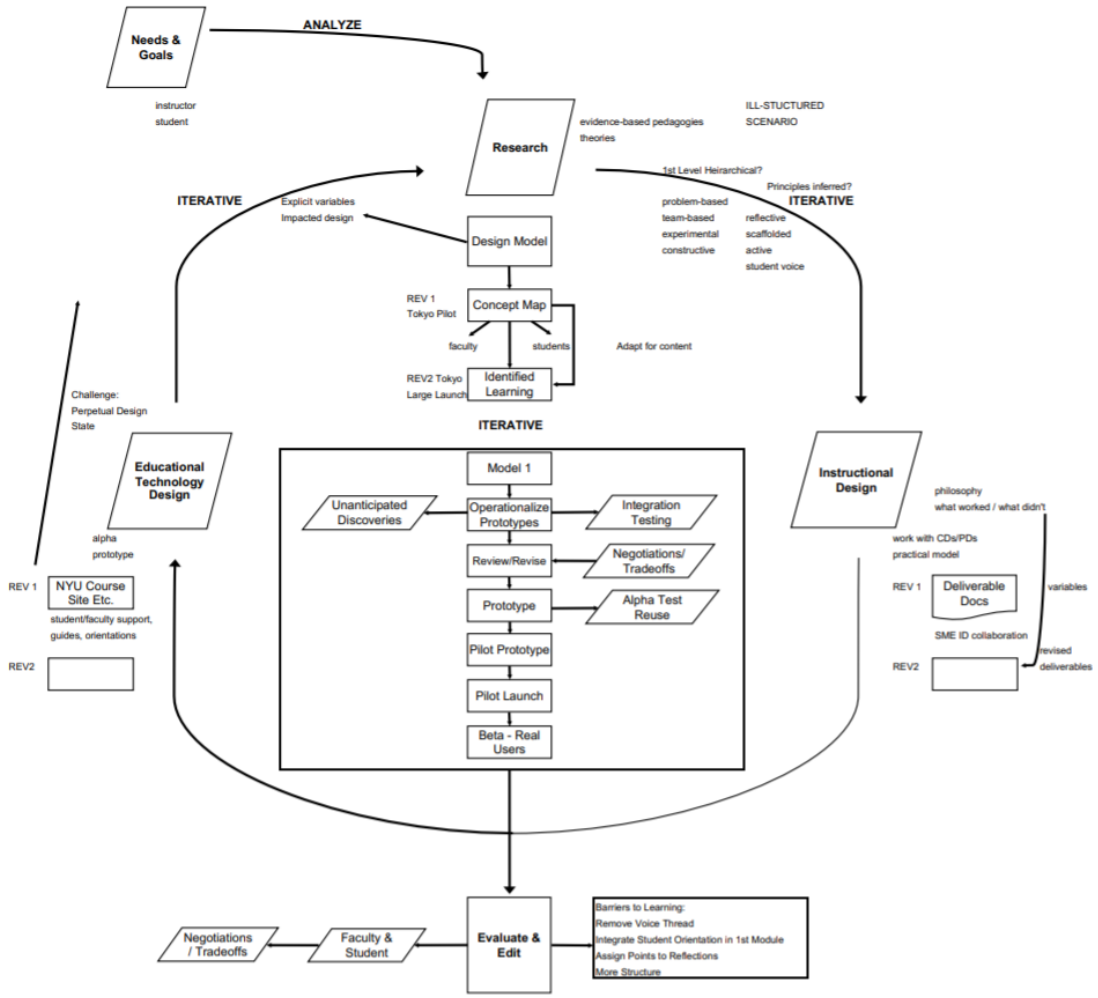


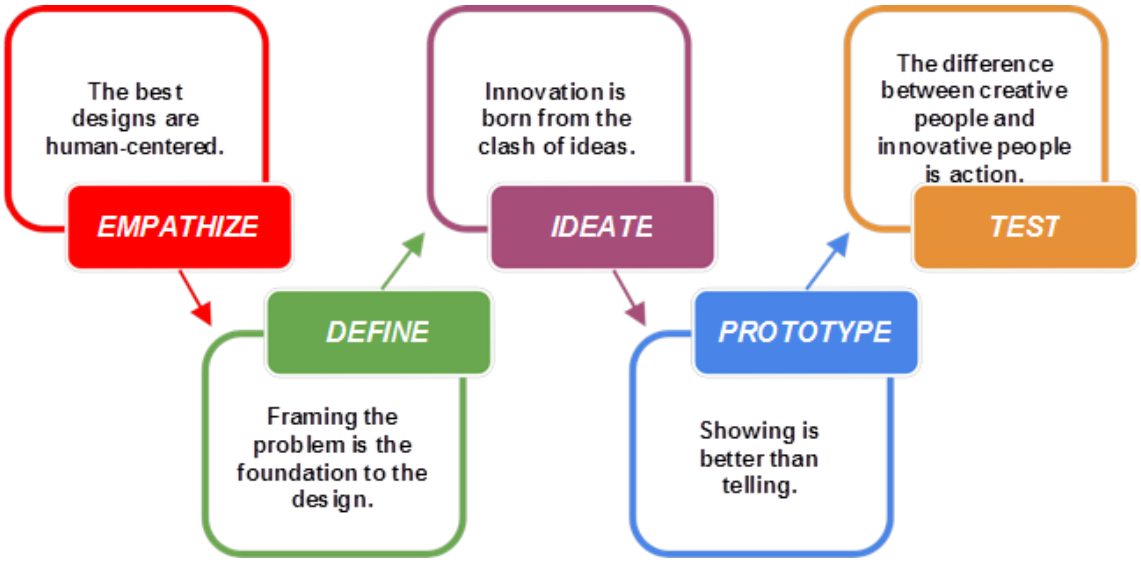
Figure 1. Flowchart Proces EPBL

PURPOSE OF THE PROJECT

Learners negotiate understandings about knowledge and achieve learning through multiple sensory channels while activating prior knowledge and layering new skills based on relatable stories and newly learned concepts (Kolb & Kolb, 2006). Since the late 20th century, leading educational researchers such as Chickering and Gamson (1987), Gagne (1985), and Merrill (2002) observed that active learning strategies lead to more engaged learners. Therefore, improved learning will take place. Active learning strategies align with other validated teaching practices, such as engaged pedagogy (Edgerton, 2001; Pascarella & Terenzini, 2005; Smith, Sheppard, Johnson, & Johnson, 2005), learner-centered learning, and interactive engagement. Well-recognized strategies include inquiry learning, problem-based learning, and collaborative learning. As Birdwell, Roman, Hammersmith, and Jerolimov (2016) observed, for "active and collaborative learning

approaches," the need exists "for a reflective pedagogical observation tool specific to the context of active learning" (p. 29).

The ill-structured problems of experiential problem-based learning connect students' prior knowledge, experience, and examples to new cognitive thinking skills with support and structure while encouraging diversity of thought and flexible solutions through conscious decision making. This project was designed to foster students' cognitive, creative, problem-solving, and technological skills for their contributions to today's global, competitive industries. Figure 2 shows the principles of the project and the overall design.



Phases*	Description & Methodology	Results
Analysis	Analyze needs for learning program and target learner characteristics. • Industry, Faculty Expertise, Course Data Analysis, Faculty Reflections • Institution Data, Institutional Effectiveness, Assessments • Key stakeholder needs and expectations, and target learner characteristics	• Program description & outcome • Individual course learning objectives • Initial understanding of instructional approach
Design	Design learning experience to achieve program outcome and learning objectives. • Course content segmentation and sequencing • Instructional tactics, application of instructional theories and principles, problem-based & experiential learning • Multimedia, active learning experiences • Resource selections (liaise with Library)	• Course syllabus • Detailed design document that will be used as basis for program & course development
Development	Produce complete course package including all learning activities and materials, build course (on the hosting platform if needed).	• Complete program and course package
Implementation	Implement the designed program/course. • Learner registration & ongoing learner support	• Learner complete learning experience in program/course
Evaluation	Evaluate program/course effectiveness against established program/course outcomes and learning objectives • Formative and summative evaluation • Feedback/results used for continuous improvement of program/course	• Evaluation results • Action plan for program/course improvement

Figure 2. Principles guiding the project and phases

THE LEARNING MODEL AND CONCEPT MAP

A focused literature review was conducted after industry forum members indicated their desire for employees who could solve complex problems, discover valid and applicable information, work in teams, and transfer skills from one context to another while providing feasible solutions (Avdiji, Elikan, Missionier, & Pigneur, 2018; Brown, 1992; Dolmans, Michaelsen, Merrienboer, & Van Der Vleuten, 2015; McKenney & Reeves, 2014). The new model was born from prior work, combined and enhanced. Thereafter, teams of learning and teaching experts conducted over a dozen feasibility forums and iteratively improved the model. During and after the pilot of four courses (see Table 1), further technology and frameworks were simplified based upon student and faculty feedback.

Finally, the Experiential Problem-Based Learning (EPBL) concept map, Figure 3, was created to guide the project. The model in Figure 3 is divided into three parts. The first is the EPBL master scenario, framework, and components of learning styles. The second part delineates instructor roles, responsibilities, and strategies. The third outlines parallel

student roles, responsibilities, and activities aligned with instructors' and the model as a whole. This model was initially intended as an early guide but become a guiding resource, with the addition of team-based learning as a complimentary theory that would address our design goals and challenges.

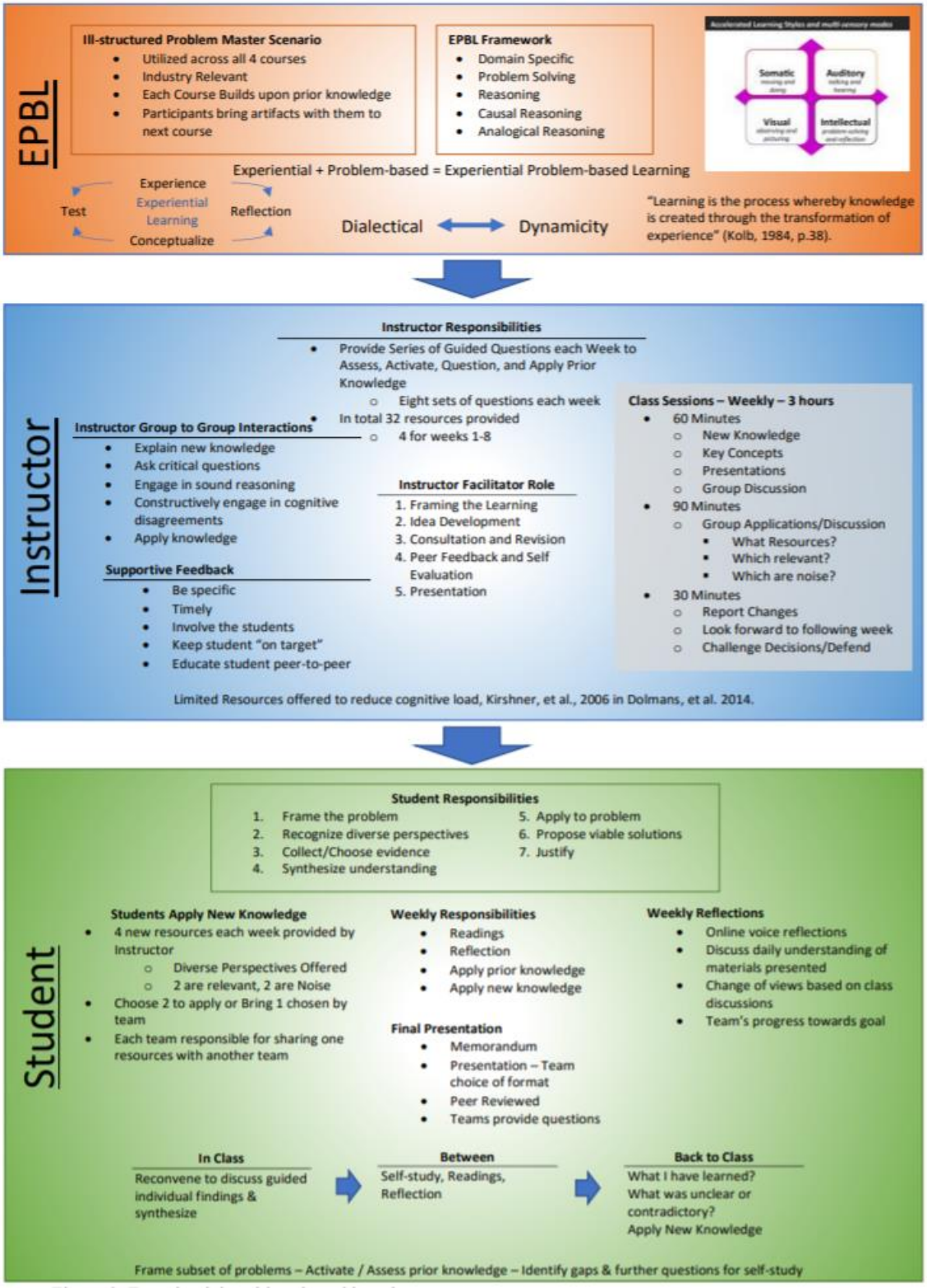


Figure 3. Experiential problem-based learning concept map

The model includes unique applications and theoretical combinations in an ill-structured problem-solving design and teaching model for an entire program. Ill-structured problems are not clear cut or well-defined; they result from specific contexts, have no obvious steps for solution, and include many unknowns. Moreover, these types of problems demand much thought, openness to alternatives and expansive overviews for solutions (Grohs, Kirk, Soledad, & Knight, 2018; Jonassen & Hung, 2015).

Through the ill-structured problems, students learn critical thinking and problem-solving skills. Learner-centered learning rather than the traditional passive learning has increased in recent years (Baeten, Dochy, Struyyen, Parmentier, & Vanderbruggen, 2016). In problem-based learning, the students develop from passive to active and the instructors develop from lecturers to facilitators. The pedagogical approaches in the model employ problem-based learning that provides them with the opportunities to take risks, receive feedback, and try new solutions that are evaluated by the industry experts and their peers - just as they would in the real world.

In our model, the courses are holistically integrated and scaffolded for an intensive and long-term learning experience (Kim & Lim, 2019). It includes many of the most evidence-based approaches, such as reflective, authentic, and active learning and learner-centered teaching. Multiple educational technologies further enhance the model, including expert podcasts, e-portfolios, digital discussions, embedded assessments and resources, and learning pathways. All encourage breaking down of classroom insularities and continuing engagement and learning between and long after the in-person components. Flipped learning, in which class time is spent on team-based problem-solving, is not a new concept (Flipped Learning Network, 2014; Reigeluth et al., 2017a). Combined with the other design elements, flipped learning provides for flexibility of strategies, support and facilitation for application of the knowledge, and peer-to-peer dialogue and feedback.

Although the research indicates that problem-based learning can increase critical thinking skills, it also indicates that PBL can devolve into chaos (Jones, 2006; Ribeiro, 2011; Ward & Lee, 2002**)**. To mitigate this drawback, we designed student and faculty facilitation and problem-solving guides and provided orientations that specifically addressed this risk and how to manage and teach through it. Faculty and student trainings prepare both groups for their unique roles and provide additional support for the model and help to overcome the reported chaos, fear, and intimidation (Pee, 2019) that can accompany an ill-structured learning environment.

Student training took place prior to each session, and time on task was estimated at 2 to 3 hours, with elements to be reinforced and applied during classes. The training, initially provided to students online to complete at their own pace, was changed for incorporation

in the first in-person class to assure completion. Students received learning and problem-solving guides and a student handbook to provide structure and transferable techniques and strategies to increase self-efficacy and supply low-risk settings for learning new cognitive capabilities. Materials and resources remained online for students to access at their need.

The faculty were trained by CAES instructional designers who facilitated the EPBL faculty orientation and training. Time on task was approximately 4 hours, with a 2-hour synchronous session. Throughout, Bloom's Taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956) was utilized as a guide for the instructors for transmission to the students: from lower-order thinking skills (knowledge, comprehension) to higher-order thinking skills (application, analysis, synthesis, evaluation).

Finally, the teams of designers and subject matter experts worked in a unique setting; the subject matter experts also received training on the model to assure understanding as the design moved forward. Additionally, modeling and testing student and faculty user experiences simulations and forums altered the tasks but not the theoretical structure. Through weekly design and technology forums with the designers and educational technologists**,** problems were exposed and the model was refined accordingly.

In the forums, potential conflicts about academic rivalry between industrial designers and educational technologists did not appear to be issues. Perhaps members of both groups recognized the complementarity and benefits in information, resources, training, and real-world applications. A case in point was a successful collaborative project of furniture production in Turkey with student and business owner evaluations "between academia, which is more close to design, and industry, which is more close to production" (Ali Altin, 2016, p. 193).

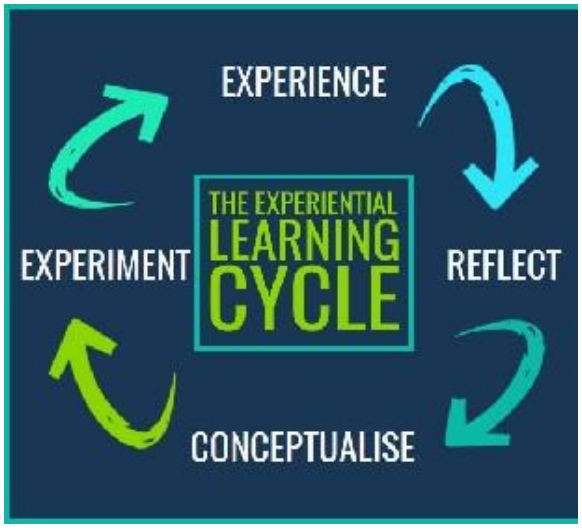
In ongoing development, multiple compatible pedagogical strategies further accentuate the learning and educational technologies, such as expert podcasts, e-portfolios, embedded resources and assessments, digitized learning pathways and a fully accessible learning management system. This system includes a full map that provides faculty and students with a clear learning pathway from the broader program learning outcomes to the course and module learning outcomes. The map illustrates how the learning is scaffolded and organized. More importantly, the map shows how all components are connected. Finally, the course Canvas page for access by all instructors and students for discussion, feedback, and resources is engaging and interesting for viewers.

Thus, this EPBL project is innovative and comprehensive and integrates theory and practice. The project incorporates teams of experts in instructional design, technology,

subject matter, and industry; unique training and orientation of instructors and students prior to course implementation; blended learning strategies and use of the latest modes of technology; consistent summative evaluations for ongoing improvements and refinements; and pilot implementation and testing in one international venue (Tokyo). Figure 4 shows a broad overview of this project.

01. Global Education

Enabling students to understand the links between thir own lives and those of people throughout the world.

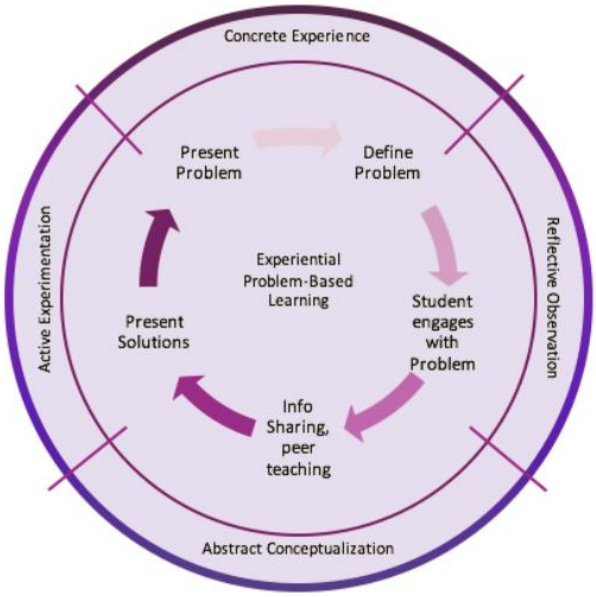


02. Experiential Learning

Giving students the opportunity to learn by reflection on doing.

03. Problem-Based Learning

Focusing on real-world, industry-relevant ill-structured problems.



04. Experiential Problem-Based Learning

Blending the strengths of Global Education, Experiential Learning and Problem-Based Learning.

Figure 4. Comprehensive overview of the Experiential Problem-Based Learning Project

LIMITATIONS

The model is multifaceted and complex, and the design, delivery and technologies are coordinated to flow seamlessly with the orientations and learning pathways, However, the students in the first pilot did not complete the orientation prior to beginning the course. We moved the orientation to the first in-person class to assure preparedness. Technologies are also important to the model's success to ensure students' comfort and ease in using technology. Thus, additional changes to streamline the model were implemented for the second cohort. Students' confidence in framing assumptions, using their voices to make choices, locate some of the needed resources, activate their prior learning, and other learner-centered approaches are new for most. Acclimation to EPBL by both students and faculty was the greatest challenge, but the trainings and orientations helped to overcome the challenges during the initial class.

Nevertheless, initial testing of the model revealed promising results, reported next. The model connects and incorporates fundamental principles, theories, and pedagogies with design decisions, as well as inputs, processes, and outputs in relation to each other (Romiszowski, 2016). This academic model for the development of students' independent and critical thinking skills, as well as their practice in real-world problems and solutions, can act as a process and guide for institutions, departments, individual faculty, and certainly students.

TESTING THE MODEL: DATA COLLECTION AND ANALYSIS

The model and initial implementation have been tested in two pilot studies with students at the New York University School of Professional Studies (NYUSPS) Global Executive Certificate Program in Tokyo, Japan. Students were enrolled in one of five Global Executive Certificate Programs: Marketing, Professional Writing, Data Analytics, Entrepreneurship, and Cybersecurity; the largest percentage of students were enrolled in Marketing and Data Analytics.

The evaluations took place in Tokyo, Japan, at the Global Executive Program with a total of 65 students**.** The survey items varied from 34 to 36 items on 4-point Likert-type scales, and including four open-ended items. Topics included names and number of courses taken, usefulness of course materials, homework, helpfulness of technology, quality of instruction, problem-solving guides, student reflections, and other elements of EPBL.

The surveys were administered to cohorts of students at the end of the Spring 2018, Summer 2018, Fall 2018, and Winter 2019 terms. The data were analyzed with descriptive statistics, frequencies and percentages, for the close-ended items. Responses were collected for the open-ended items.

RESULTS

The results overall were positive. Table 1 displays the survey results by frequencies and percentages for specific components of the program for the student in the four cohorts.

Item	Spring 2018 (*N* = 6)		Summer 2018 (*N* = 21)		Fall 2018 (*N* = 16)		Winter 2019 (*N* = 22)	
The problem-solving guides were . . .	NA[a]	NA	Very Helpful 52.38% (11)	Somewhat Helpful 47.62% (10)	Very Helpful 25.00% (4)	Somewhat Helpful 56.25% (9)	Very Helpful 54.54% (12)	Somewhat Helpful 36.36% (8)
The student reflections were . . .	NA	NA	Very Helpful 47.62% (10)	Somewhat Helpful 33.33% (7)	Very Helpful 31.25% (5)	Somewhat Helpful 56.25% (9)	Very Helpful 72.72% (16)	Somewhat Helpful 5.50% (4)
My learning experience continued and was enhanced through online sessions.	NA	NA	Strongly Agree 42.86% (9)	Agree 47.62% (10)	Strongly Agree 25.00% (4)	Agree 68.75% (11)	Strongly Agree 45.00% (10)	Agree 45.45% (10)
After completing this course, my ability to FRAME a problem has . . .	NA	NA	Improved Significantly 52.38% (11)	Improved Somewhat 42.86% (9)	Improved Significantly 25.00% (4)	Improved Somewhat 75.00% (12)	Improved Significantly 31.81(7)	Improved Somewhat 59.10 (13)
After completing this course, my ability to SOLVE a problem has . . .	NA	NA	Improved Significantly 47.62% (10)	Improved Somewhat 42.86% (9)	Improved Significantly 6.25% (1)	Improved Somewhat 87.50% (14)	Improved Significantly 27.27% (6)	Improved Somewhat 63.64% (14)

Item	Spring 2018 (*N* = 6)		Summer 2018 (*N* = 21)		Fall 2018 (*N* = 16)		Winter 2019 (*N* = 22)	
After completing this course, my ability to justify my solution . . .	NA	NA	Improved Significantly 33.33% (7)	Improved Somewhat 57.14% (12)	Improved Significantly 12.50% (2)	Improved Somewhat 81.25% (13)	Improved Significantly 31.81% (7)	Improved Somewhat 59.10% (13)
After completing this course, my ability to recognize diverse perspectives has . . .	NA	NA	Improved Significantly 61.90% (13)	Improved Somewhat 33.33% (7)	Improved Significantly 25.00% (4)	Improved Somewhat 62.50% (10)	Improved Significantly 27.27% (6)	Improved Somewhat 72.72% (16)
After completing this course, my communication skills have . . .	NA	NA	Improved Significantly 33.33% (7)	Improved Somewhat 61.90% (13)	Improved Significantly 6.25% (1)	Improved Somewhat 68.75% (11)	Improved Significantly 18.18% (4)	Improved Somewhat 63.64% (14)
After completing this course, my reasoning skills have . . .	NA	NA	Improved Significantly 47.62% (10)	Improved Somewhat 42.86% (9)	Improved Significantly 6.25% (1)	Improved Somewhat 75.00% (12)	Improved Significantly 22.72% (5)	Improved Somewhat 68.18% (15)
The teacher helped me reach my learning goals.	NA	NA	Strongly Agree 81.00% (17)	Agree 19.04% (4)	Strongly Agree 43.75% (7)	Agree 56.25% (9)	Strongly Agree 68.18% (15)	Agree 31.82% (7)
My course was effective in helping me achieve my goals.	Strongly Agree 16.67% (1)	Agree 83.30% (5)	Strongly Agree 66.67% (14)	Agree 28.57% (4)	Strongly Agree 31.25% (5)	Agree 68.75% (11)	Strongly Agree 45.45% (10)	Agree 54.54% (12)

Table 1. Student Evaluations: Results for Selected EPBL Items

Note: NA means that the first cohort did not complete.

With regard to quantitative results, Table 1 shows that for all four courses, the majority of students responded positively in many areas. On the 11 selected items especially regarding EPBL, for the Spring 2018 cohort, because of incompletion of the course,

almost all items could not be answered. However, for course helpfulness in reaching students' goals, all chose Strongly Agree, 17%, and Agree, 83%. For the Summer 2018, Fall 2018, and Winter 2019 courses, most students evaluated the courses with the highest values of Very Helpful or Somewhat Helpful, Strongly Agree or Agree, and Improved Significantly or Improved Somewhat. In all cases, the students rated the courses primarily with these values, indicating their satisfaction.

With regard to qualitative results, in the surveys students were asked to explain their short-answer responses with four open-ended questions. Some of their responses:

From Spring 2018:

- This course helped me to change my perspectives and to make assumptions to find the problems and the solutions.

From Fall 2018:

- Teacher was very helpful but student problem-solving guide which is recommended by NYU was sometimes too complicated or not appropriate to solve the module problems.
- It was good course to improve my critical thinking skills but the given questions to answer were too general or vague so it was a bit confusing to answer.
- Overall it was a great experience to study at NYUSPS Tokyo not only to improve my skills but also to play the role to lead the discussion etc.
- The contents of the course itself is completely recommendable. . . . In our class we have only two students including myself. If we have at least three, our discussion in in-person classes would be more active and we could get various ideas or opinions.
- Instructor totally supported me during the course program; thus, my abilities might be able to increase accordingly.
- I think the course was well organized with good reading materials. I just could not spend enough time for the online learning materials.

From Winter 2019:

- From the NYUSPS teaching experience, I am persuaded that after completing all necessary courses, I will confidently be able to solve business problems to help companies successfully competing locally and globally by prioritizing digital marketing innovations.
- I well appreciate NYUSPS and recommend NYUSPS courses to other people who have interest in knowledge improvement.

- As new in the marketing field, the skill and tools received from the introduction to marketing lead me to another step by improving my background.
- I am persuaded I will finally break into business game because of the competitive skills that I am gaining from Tokyo NYUSPS.

Course developers and instructors had these comments:

- Creating a course-level problem for EPBL is a fascinating experience in itself, pushing you to reflect on the real-world industry challenges (course developer).
- EPBL is a solid methodology that turn a simple student into an active researcher, a thought provoker, it brushes away the common passivity found in a traditional classroom (instructor).
- In places where rote learning is still the educational standard, EBPL is especially crucial, however discombobulating it may be to students at first (instructor).
- Typically, students initially seek "right" answers from learning materials or instructors' comments. Over time, many of them realize that they are responsible for reaching their own conclusions and that they can be confident about their thought process (instructor).

DISCUSSION AND FURTHER PLANS

Although the student samples were small, the results as a whole were positive. All students in the four courses either strongly agreed or agreed with the statement "Overall, I am satisfied with my NYUSPS Tokyo experience." For Summer 2018, 50% (3) Strongly Agree, 50% (3) Agree; for Summer 2018 81% (17) Strongly Agree, 19% (4) Agree; for Fall 2018, 31% (5) Strongly Agree, 69% (11) Agree; for Winter 2019, Strongly Agree 63.64% (14), Agree 36.36% (8). With regard to the selected items relating to EPBL, for all items, 75% to 100% of students in all cohorts chose the top two values (Very Helpful, Somewhat Helpful, Strongly Agree, Agree, Improved Significantly, Improved Somewhat). Most of the combined values were in the 90% to 100% range. A major goal of the model was reached: students learned and practiced critical and creative thinking and increased their communication skills. Student and instructor comments supported the efficacy of the program.

At present, the EPBL project has been implemented with courses in the United States and Japan. We are also offering two fall workshops for NYU faculty. In continuation of the program, nine more courses and evaluations launched in the summer of 2019, including

feedback not only from faculty and students but also from instructional designers and industry experts.

The School of Professional Studies at NYU has 16 master's programs, four new masters coming in the next year, nine bachelors, and several associate degrees. In addition, we offer hundreds of noncredit courses every year, including our Certificates and Diplomas. However, the model itself is not limited to these early programs but can potentially be utilized as well for professionally-oriented education degrees, certifications, and lifelong learning offerings.

Future evaluations of the model would include additional faculty and student evaluations in New York, Tokyo, and other international venues, with comparisons of these to the earlier evaluations, and adjustment of the curricula as necessary. In addition, after students are trained in using the model, the industry forums could evaluate the students' competencies, in contrast to the students' own evaluations. Further, students' views on the helpfulness of EPBL could be tracked to subsequent employment after they have been in the field, as well as their employers' assessments of their competencies. In addition, the involvement of different organizations and individuals, such as input from professional associations and CEOs, could be explored to refine and extend the model, as well as suggest directions for future research and applications.

The model and support structures have been completed so that scaling to larger programs and new contexts can be readily accomplished. Although a learning management system is required, it can be translated to any learning management system. The orientations, training, frameworks, and design templates, and trainings are also complete and can be scaled to any number of sections. Additionally, although some students evaluated the model as "complicated," the responses were nevertheless positive. Thus, the model can be transferred to other educational areas and disciplines**,** such as the biological and environmental sciences, information technology, economics, social sciences, and leadership.

The problems that the model seeks to address are universal. This new model can theoretically be transferred to almost any discipline or programs with creativity and disciplinary and taxonomy contextualizing. Good EPBL problems in whatever field can, with creativity, be adapted to any field (Duch, Grow, & Allen, 2011). Common characteristics distinguish the problems. They should be open-ended and ill-structured. They should be complex, although with a degree of complexity that embodies the following:

- They should engage students' interests, be challenging, and motivating enough to prompt students to seek a deeper understanding of the concepts involved.
- They should require students to make reasoned decisions and defend them.
- They should incorporate the content objectives.
- They should relate to students' prior course and life knowledge.
- They should enable students to analyze the problem[s] from multiple perspectives or disciplines;
- They should be adapted to students' cognitive development and readiness.
- They should be formulated to relate to students' future or potential workplaces.
- If a group project, the problems must have enough complexity to ensure students work together to solve them. (Duch et al., 2001; Jonassen & Hung, 2015)

CONCLUSION

In this article, the EPBL model has been presented highlighting holistic components and theoretical support. To experiment with or adapt this model, several preconditions are necessary. These include training of staff in the model and technology use, creation of handbook that addresses particular disciplines and educational areas directly, applications to real-world scenarios, and orientation of students to the model and mode of learner-centered teaching and the requirements, as instructors and students commented on. The primary considerations to be aware of are possible confusion on the stages of the EPBL problem-solving guides for both staff and students (as students commented on) and built-in periodic refresher training and/or troubleshooting with a staff member or faculty member who has worked with the model. Further, monitoring of the model success should take place with staff and student feedback, preferably before the end of the course so that corrections can be made.

An observation must be made on the use of the model created in New York City and implemented in Tokyo. All students were part of the New York University Global Executive Program delivered in Tokyo, and all were Japanese. To this member of the team, it was particularly impressive that the students were eager and open to mastering this challenging method of learning, especially because, like U.S. learners, the cohort members were accustomed to a highly structured faculty-directed learning environment.

As reported, the students also had high praise for the courses and saw the applications to their future careers.

The current surveys did not include a cultural component either for orientation to the model or in the surveys. With implementation in other educational areas and international programs, a cultural component could be added. This component would take into account traditional modes of learning and mores to tailor the curriculum for maximum effectiveness in each setting.

The EPBL model described here is an innovative and highly industry- and evidence-based transformative educational model that addresses many of the problems and challenges of today's higher education. With implementation, the model prepares students to grapple with the unknowns, draw on their life experiences, and holistically consolidate their learning for applications vitally necessary in industry and many other fields in the 21st century.

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Individual Reflection Paper – Supporting Students' Learning in the Critical Phase of Self-directed Learning in PBL

Madelaine Johansson and Teresia Svensson *

ABSTRACT

Supporting and assessment of students' preparation and learning process in problem-based learning (PBL) tutorials has long been a challenge. We present a modified PBL model focussing on the specific critical phase in the PBL process, the self-directed learning phase in between tutorial meetings. The modified seven step PBL model including an Individual reflection paper (IRP) is presented as well as students' perspectives on the implementation of IRP and information literacy, knowledge gathering, and PBL tutorial work. The assessment of PBL work is complex, and the ways in which IRPs support the tutor's role as an examiner is beyond the scope of the current study. However, it seems that the students experienced assessment of the IRPs as part of their as a positive driving force in their learning process.

INTRODUCTION

In a modern society, we need to educate students who are able to manage complexity and uncertainty, not least regarding environmental and sustainability challenges (Barnett 2012). Students must develop certain skills, including interdisciplinary professional skills, technical and analytical abilities, and cognitive abilities such as critical thinking (Bedrow and Evers 2011; Boud and Molloy 2013; Dolmans et al. 2015). Contemporary pedagogical theory advocates student-active and student-centred education which should scaffold the development of the student's cognitive competences including creativity, academic writing, critical thinking, and reflection skills (Ramsden 2003; Biggs and Tang 2011). Nevertheless, the effectiveness of different pedagogical concepts is strongly dependent on how they are implemented and applied in education. Problem based

* Madelaine Johansson, Centre for Academic Development, Karlstad University
Email: madelaine.johansson@kau.se
Teresia Svensson, Department of Thematic Studies – Environmental Change, Linköping University
Email: teresia.svensson@liu.se

learning (PBL) is a well-known method to manage complex scenarios and cases with no or little information, and reflection and critical thinking are natural parts (Savin-Baden and Howell, 2004a; Savin-Baden and Wilkie 2004). PBL is in many aspects a suitable pedagogical method in higher education, but needs careful design and well-thought-out implementation (Hung 2011).

One challenge in the PBL context is to provide instruction design and instruments to support creativity, deep learning, and motivation for self-directed learning and development (Joham and Clark 2011). Implementation of PBL can vary among educational settings, but commonly involves the seven steps where the initial steps to identify define the problem and formulate learning needs are covered in the first tutorial followed by individual studies before the discussing the findings again at the next tutorial group (e.g. Moust et al, 2005). In PBL, students take the full responsibility for their studies and learning in PBL *between* the meetings and thus this is a critical phase in PBL to achieve fruitful discussions and learning at the tutorial meetings. Despite the emphasis on student-active learning, studies have revealed problematic issues related to instruction design and self-directed learning (Dolmans et al. 2001; Moust et al. 2005; Hung 2011). Earlier studies have shown that some students don't spend enough time on self-studies and searching literature, which results in a superficial and substandard preparation for PBL work (Hung 2011). Thus, the groups collective learning ability as well as the individual learning might be at risk. There are also studies on the importance of knowing how instructions in PBL settings can influence the time students allocate for self-studies to improve the quality of teaching (Ruiz-Gallardo et al, 2016). The interdisciplinary bachelor's programme in environmental science at Linköping University, Sweden has implemented a new instrument, Individual reflection paper (IRP) (in Swedish: Individuellt basgruppsunderlag [IBU]), in the PBL process to support students learning process in the specific critical phases between the tutorial meetings. The tool has been used in PBL at the Environmental Science programme at Linköping University since 2005 and has thereafter also been implemented successfully at other educational programmes for instance at the Faculty of Medicine and Health Sciences at Linköping University. Almost twenty years of instructional experience in this programme have led to the increased awareness of students' self-studies and assessment challenges related to PBL and tutorial work. Grading and assessment of students' contributions in PBL tutorials is a well-known challenge and have been analysed and written about in pedagogical literature for a long time. Today, we recognize a variation in assessment formats; it is not only the control of content knowledge that is in focus, but also performance and the learning process (Dreissen and van der Vleuten 2000; Eva 2001, Hung 2011). We will here describe the modified PBL model and the response from the students on how IRP are influencing their learning process and regular tutorial work.

MODIFIED PBL MODEL WITH INDIVIDUAL REFLECTION PAPER

The work in tutorial groups is based on PBL, which in the literature is often referred to as a model of seven steps (e.g. Moust et al, 2005), and a modified model is used in the present programme, (see Figure 1). A scenario is distributed to the tutorial group (6-8 students), and the students formulate their learning needs and questions for their self-studies until next meeting. Each student is asked to compile and document their learning of and reflection on the jointly-formulated questions or tasks in an individual reflection paper (IRP) prior to each meeting. The student's engagement and contribution in tutorials are assessed and graded by the tutor, with one criterion being "active participation"; this includes both preparation and contribution to learning through discussions during the tutorials. Thus, the introduction of IRP also enabled more rich material for assessment of how well-prepared the individual students to the tutorial meetings.

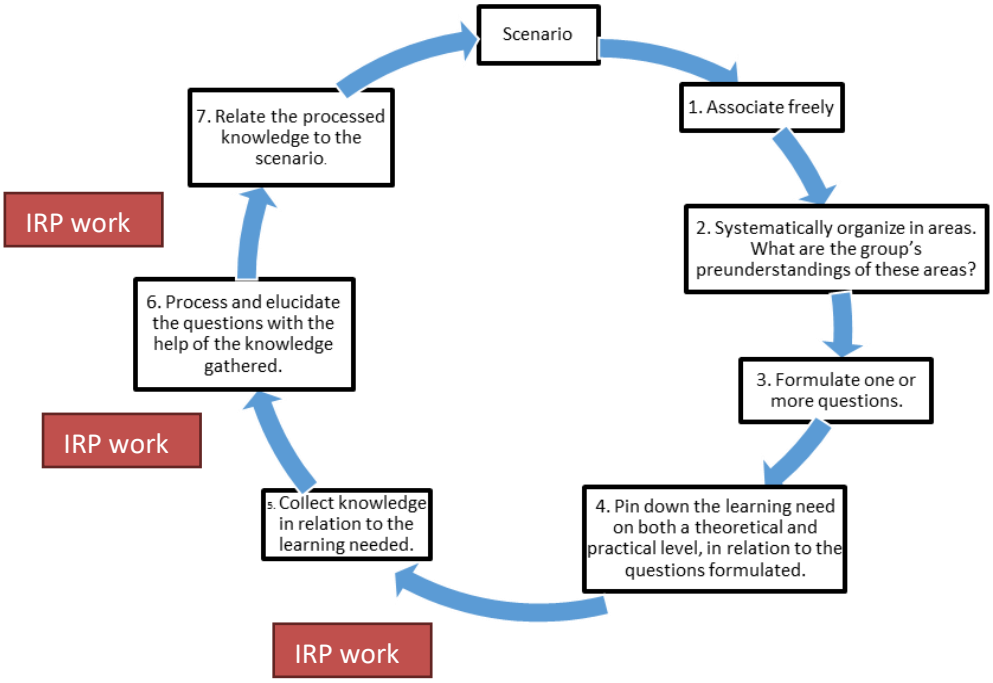

Figure 1: The problem-based learning model that describes the learning process used in the tutorial groups (6-8 students) at the Linköping University environmental science programme. The IRP work is the preparation of the students themselves. The IRP process consists of three steps: 1) At the end of a tutorial meeting, the students agree on their learning needs on both a theoretical and practical level in relation to the questions formulated, and start seeking information. Each student then writes their own IRP on the basis of their individual studies and reflections on new knowledge. As the IRP is restricted in length, the student has to choose and then formulate what they think would best summarize a response to the group's common issues. Students also often formulate discussion questions for the upcoming tutorial meeting in their IRPs. 2) Before the next tutorial meeting, the students all read each other's IRPs. 3) At the following tutorial meeting, the students discuss the gathered knowledge. In conjunction with this, they discuss their IRPs and how the new information gathered relates to the scenario.

Students are informed about the IRPs at the start of the first course of the programme, both in a written document and in a lecture, and are repeatedly reminded via written course guides during all courses. The information provided includes the statements that the IRPs are "…aiming to support your own learning while working in tutorial groups", and that the most important function is that "…every student should individually summarize and document their gathering of knowledge and reflection". The outline of the IRPs is restricted to a certain limit — "The appropriate length of an IRP is approximately one page" — but there is also plenty of freedom: "The tutorial group has a lot of freedom to choose how the IRP should be designed…". The students are assessed through student-active participation in the tutorial group work, and the IRPs are an important part of this. The assessment is made on a three-level scale (fail, sufficient, good) and is divided into two parts: preparation and constructive participation.

MATERIAL AND METHODS

The study design consisted of two parts: a questionnaire distributed to all students in programme and three focus group interviews with selected students from the first, second, and third years. The questionnaire and focus group interviews focused on the following areas; IRPs supporting students' learning, IRPs supporting the regular work in tutorial groups, and possible influence of assessment of IRPs and time spent on IRPs. The questionnaire was distributed online to all students in the programme; 152 students answered, giving an answering frequency of 78% among all students. In addition to the questionnaire, we chose to use focus groups and take a qualitative approach since we were interested in the students' experiences of using IRPs in teaching. A benefit of focus group interviews in relation to the more traditional group interviews is that the participants have increased opportunities to give feedback on each other's thoughts and experiences (Barbour and Kitzinger 1999). We selected 6 students from the first year, 5 students from the second year, and 5 students from the third year. We separated the students by the year of study, and all focus group interviews lasted 0.5-1 hours. The interviews were performed at the end of the spring semester; that is, at the end of a study year.

FINDINGS

The majority (>90%) of students of all years stated in the questionnaire that they thought the IRPs supported their regular tutorial work. The students in years 1 and 2 seemed to draw more support from the IRPs than students in year 3. When we asked in what ways the students thought the IRPs supported the tutorial work, the most important aspects were support for better discussions, and providing all students with the opportunity to show participation. This can be interpreted as meaning that the IRP is an instrument that

discourages the type of dysfunctional group interaction identified by Hung (2011), namely problems related to preparation and contribution. One of the students expressed the driving potential that IRPs might have:

- "Without IRPs, the level of discussion would become too low and some people wouldn't prepare properly." (Questionnaire, year 2)

The students also described use of the IRPs as an iterative instrument that support their own understanding of other students' perspectives and thoughts, and even reduce conflicts:

- "there are far fewer misunderstandings if we all spend time on the IRPs, because then you realize that a lot of what you think are differences are actually the same thing. Reading each other's IRPs can let you bypass a lot of the everyday fuss." (Focus group, year 3)

The students thought the use of IRPs as part of the assessment of tutorial group work had a substantial effect on the IRP process (average 77%). However, this effect was not a negative one, but instead more positive. When asked what primarily influenced their work on IRPs, many of the students answering the questionnaire stated that IRPs being part of the assessment increased their ambition level. It therefore seems that using IRPs as part of the assessment of the students' tutorial work led to a positive motivation for the learning process.

IRPs SUPPORTING STUDENTS' LEARNING PROCESSES

Based on the questionnaire, it was clear that working with IRPs supported the students' information literacy competence (Table 1). Information literacy is an important part of the PBL process; students must be able to search, identify, and evaluate information about the problem/question at hand. The students mainly referred to the relevance and quality of the sources and expressed that their usage of sources had developed over time. The development over the years seemed to be linked to scientific anchoring, and the students' having reflected on the information they had gathered.

- "I also think of referencing, good referencing with good sources and reflection [...] that it's relevant, not just a reflection throwing out words, or that the IRP looks better than it is [...] so I don't see a direct difference in the number of words when it comes to the quality of the IRP, as it were." (Focus group, year 2)

IRP work supports my own information literacy		**Agree fully**	**Partly agree**	**Do not agree**	**Do not know**
	Years 1-3	74%	18%	2%	
	Year 1	72%	19%	2%	
	Year 2	84%	13%	0%	
	Year 3	66%	22%	0%	
I gain insight into my own skills and knowledge gaps	**Years 1-3**	**34%**	**53%**	**1%**	**6%**
	Year 1	32%	60%	0%	2%
	Year 2	44%	45%	0%	7%
	Year 3	24%	54%	2%	8%
IRP work supports me in gaining a deeper understanding of the subject	**Years 1-3**	**43%**	**40%**	**1%**	**8%**
	Year 1	55%	34%	0%	4%
	Year 2	45%	38%	2%	9%
	Year 3	28%	48%	2%	10%
IRP work supports me in contributing constructively to the discussions at the tutorial meetings	**Years 1-3**	**59%**	**31%**		**3%**
	Year 1	57%	34%		2%
	Year 2	64%	29%		4%
	Year 3	56%	30%		2%
IRP work supports me in seeing multiple perspectives	**Years 1-3**	**56%**	**33%**	**4%**	
	Year 1	51%	34%		9%
	Year 2	71%	25%		0%
	Year 3	44%	40%		4%
IRP work supports me in formulating relevant questions	**Years 1-3**	**37%**	**45%**		**9%**
	Year 1	45%	45%	0%	4%
	Year 2	33%	51%	2%	11%
	Year 3	34%	40%	4%	10%

Table 1: Questionnaire responses to the question: Do you consider that your own learning has been enriched by the IRPs? If yes, how?

There was a clear progression among the students from year 1 to year 3 in what they described as characterizing a *good* IRP. First year students in the focus groups said that good IRPs should include relevant content and one's own reflections, while the third-year students spoke about reflection at a more metacognitive level; for example:

- "[...] in a way, it helped me to write down how I think, in a way I didn't see when I collected my facts; I needed to reflect on where I found it, and yes, it helped in a way to think, you write down how to think about the facts you see." (Focus group, year 3)

It was clear that the content was of most importance, meaning that one should report the information gathered. The second-year students had developed this further, and more frequently described the importance of scientific anchoring of the IRPs and using relevant sources in their reflections. The students in years 2 and 3 also stressed that the content of the IRPs should be related to the questions agreed upon in the tutorial group meetings. It seems that the students at the beginning of the programme used a more or less reporting-strategy for the IRPs, including descriptions of everything they had found on the topic as well as the questions agreed upon from previous meetings. In later years, they also relate, reason about, and synthesize the information. This is corresponding to prior studies highlighting that factors influencing the students independent learning may change over the years of studies from more strict content driven studies in the beginning to more own learning needs at the end of their studies (Dolmans et al 1995). The students stressed in the interviews that how good an IRP would be also depending greatly on the type of questions formulated in the group. In a previous study, Abrandt Dahlgren and Öberg (2001) found that questions formulated by students in the tutorial process could be separated into five different types (encyclopaedic, meaning-oriented, relational, value-oriented, and solution-oriented) and that the students mixed all these questions as part of a dynamic process. Our results reveal that the students become aware of how different questions affected the tutorial discussions and their learning process by the use of IRPs. If students become aware that the more encyclopaedic questions will lead to more surface learning, they might actively add questions at a higher level to stimulate a deeper approach and stress the importance of citing and discussion of sources.

Reflection and critical thinking are skills that have been stated in several different contexts to be something that a graduate student should have achieved after completing higher education (Phillips and Bond 2004; Biggs and Tang 2011; Swedish Higher Education Act). In one of the focus groups (year 2), a student posed the question of whether the IRPs had supported their reflection processes and another student in the focus group answered, saying:

- "[…] maybe not just my own IRP, but when I read other people's and find out how they reflect on their own, then I reflect on what others see too […] I think it feels like a little piece of a puzzle in a larger puzzle at the meeting, when you meet, then you sort of get the whole thing."

The students in the later years of the programme expressed that there could also be difficulties when the writing of IRPs felt like a routine. In both the focus group interviews

and the questionnaires, the students brought up factors that influenced their work with IRPs, such as time, assessment, instructions, the role of the tutor, and students ambition level. Some of these factors seemed to have a stronger influence than others. The time allocated for the students to work with the IRPs seemed to be the aspect most commonly brought up, which is in line with earlier studies pinpointing the need for balance between workload and time allocated for the tasks (Ruiz-Gallardo et al, 2016, Hung 2011). The students explained how the quality of the IRPs become lower when there was only a short time in between the tutorial meetings. In addition, the students expressed that there was a risk of moving into a repetitive mode of learning, where they more or less only reported facts rather than summarizing and reflecting; and not have time to reach a higher level of reflection. There was also a risk that students with less time to prepare would take, what Marton and Säljö (2005) identify as, a surface approach, instead of the deeper approach required. When the students experienced that there was enough time to prepare, the students appreciated the IRPs:

- "It requires a lot of the student to make the IRP good, but if the student spends the time required, it is a very effective learning activity…" (Questionnaire, year 3)

FINAL CONCLUSIONS

The implementation of IRP in the critical phase of self-directed learning seems to fit well into the PBL process. The students primarily stressed that the IRPs were a way of being aware of the information they had gathered, and that they helped them further develop this through the discussions in the tutorial groups. In addition, the students could become more reflective in their learning processes, as they could see a progression in how their IRPs had developed over their years of study. An analysis of students written IRPs, is beyond the scope of the current study but would give more information on how the progression is formed. Assessing PBL work is complex, and the ways in which IRPs support the tutor's role as an examiner. However, it seems that the students experienced assessment of the IRPs as a positive driving force in their learning process, but further studies is needed.

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The Use of a Digital Problem-Based Learning Module in Science Methods Courses

*Peter Rillero and Ying-Chih Chen **

ABSTRACT

Teacher education in Problem-Based Learning (PBL) is requisite for improving and increasing K-12 PBL implementations. A free, online PBL module entitled "Design a Problem-Based Learning Experience" was developed for preservice and inservice teachers. This article describes how the module is used in preserve teacher science methods courses, experiences before and after the module use, and the perceptions of sixty-two teacher candidates (TCs) after module completion. The results revealed that TCs generally had positive attitudes about the module. TCs in elementary level courses had significantly higher rating than secondary level courses. Graduate TCs also rated significantly higher than undergraduate students. Analysis of interview data revealed three features of the PBL module: (1) it is concise and organized, (2) it provides effective and practical examples, and (3) it provides interactive and rigorous videos to engage learners. Potential ways to improve the online PBL are discussed.

Problem-Based Learning (PBL) can integrate diverse subjects with meaningful experiences. With exploration preceding explanation, PBL provides paths to realize state science standards, Next Generation Science Standards (McConnell, Parker, & Eberhardt, 2018; NGSS Lead States, 2013), and the Common Core mathematics standards (Nariman & Chrispeels, 2015). The approach advances a vital outcome of education: the abilities to recognize and solve problems.

PBL implementation requires different teacher roles in the instructional process (Bridges, 1992). Our Teachers College has embraced the goal of preparing teachers with the knowledge, abilities, and mindsets to effectively implement PBL. This article describes (a) the use of a PBL module in our science methods courses, (b) experiences before and after the module, and (c) preservice teachers' views of the module.

* Peter Rillero, Mary Lou Fulton Teachers College, Arizona State University
Email: rillero@asu.edu
Ying-Chih Chen, Mary Lou Fulton Teachers College, Arizona State University
Email: ychen495@asu.edu

PROBLEM-BASED LEARNING

Dewey's (1938) conceptions of knowledge being bound with activity provided a theoretical basis for PBL. Challenging the prevailing lecture and memorize method, PBL was launched in the 1970s at McMaster University as medical students learned content and clinical reasoning abilities by identifying symptoms in real patients, simulated patients, or written case studies; diagnosing medical conditions; and proposing treatments (Barrows, 1996; Barrows & Tamblyn, 1980; Zubaidah, 2005). From medical education, PBL entered other professional education programs (Beck & Lindvang, 2015; Cottell, 2010; Gould & Sadera, 2015).

PBL in K-8 Grades

Passage into grades K-12 necessitated a broader view, from foci on clinical skills or problem-solving for a single profession to preparing younger learners for many life possibilities (Marle et al., 2012; Torp & Sage, 2002). Studies of K-12 implementations are limited and frequently have conflicting results (Wirkala, & Kuhn, 2011). However, a recent systematic literature review for elementary science education, involving control-groups with PBL as the independent variable, provided evidence that grades K-8, science, PBL experiences foster academic achievement, knowledge retention, conceptual development, and improved attitudes (Merritt, Lee, Rillero, & Kinach, 2016).

PBL and English Language Learners

The population of English Language Learners (ELLs) in U.S. schools has increased steadily over the past thirty years (Shin & Kominski, 2010). When students struggle with the language in which academic content is delivered, their academic success is jeopardized (Wright, 2015). PBL can help all students, but especially ELLs who face additional obstacles, develop language and content knowledge with strategic scaffolding (Rillero & Hernandez, 2016). Yet, teachers may not believe active learning strategies should be used with ELLs. For example, Kelly describes results of a pretest and posttest after an ELL methods course (2017): "overall findings showed that preservice teachers viewed teaching ELLs as a teacher implementing direct instruction in basic literacy to passive students at both the beginning and end of the course." Teachers need to understand how to implement active learning approaches, such as PBL, to benefit ELLs and all learners.

TEACHERS AND PBL

PBL environments have free-flowing elements, nevertheless, "teachers must be intentional in the design of the learning environment and the enactment of support strategies" (English & Kitsantas, 2013, p. 130). In moving away from teacher-centered instruction, a challenge is finding balance between supports for students and autonomous work (Pepper, 2009); this challenge exists for both new and experienced teachers (Strevy, 2014). Being able to hold back instructor input is important for creating a space for student learning (McConnell, Parker, & Eberhardt, 2018). Many teachers struggle with letting go, letting students make mistakes as they work to solve a problem; others may swing to the opposite extreme, embracing student struggle but withholding too much assistance (Pourshafie & Murray-Harvey, 2013). For example, an implementation in a college of education, instructors were reluctant to give assistance, assuming students should be independent learners (Koh & Tan, 2016), resulting in students not asking instructors for assistance.

The need for PBL teacher education is deepened as most inservice and preservice teachers have not experienced PBL as learners and might not have PBL implementers to observe (Lehman, et al., 2006; Strevy, 2014). Important teacher characteristics for effective PBL implementation include skills, attitudes, and knowledge (Pourshafie & Murray-Harvey, 2013).

THE PBL MODULE

Our Teachers College received a grant to prepare our undergraduate and graduate preservice teachers (whom we call Teacher Candidates (TCs)) to work with English Language Learners and implement PBL through an approach called Problem-Based Enhanced Language Learning (Rillero, et al., 2017). Grant recipients teamed with the Sanford Design project to develop a free, online PBL module for preservice and inservice teachers entitled "Design a Problem-Based Learning Experience" (Rillero & Camposeco, 2018). A distributed white paper presented our operational definition of PBL for discussion and agreement: **Problem-based learning is an instructional approach where learners grapple with meaningful problems and collaboratively work toward their resolution.** A detailed description of the module creation process is presented by Rillero and Camposeco (2018).

The module is freely available at https://modules.sanfordinspire.org/modules/design-problem-based-learning-experience/. The launch page features an introductory video, learner outcomes, and a downloadable (a) Coaching Guide, (b) Module Resource, and (c) Transcript.

Learners start the module after a brief registration process. The chapters in the module are as follows:

1. **Introduction**: The definition, required mindsets, and benefits of PBL.
2. **Designing an experience**: Three steps of PBL and corresponding criteria for each.
    a. **Establish the problem**: Identify a problem that has real-life application and is meaningful to students.
    b. **Create the experience**: Learners plan for how students will collaborate and share their solutions.
    c. **Evaluate**: Learners identify academic and social outcomes for the experience. They also plan formative and summative assessment opportunities
3. **Tips for Getting Started**: Learners select videos of subject-matter experts explaining different tips for planning their first problem-based learning experience.
4. **Bears on a Boat**: An annotated PBL lesson plan is viewed that explains how each criterion and step are met.
5. **Evaluate a PBL Experience**: After a self-assessment, learners have the choice of either evaluating a PBL experience or proceeding to the conclusion.

After chapter completion, learners take a six-question assessment that requires a 100% score for a completion certificate, with retakes possible. We assign the module as an out-of-class experience. The submission of their certificate confirms the TCs have explored the module.

PRE- AND POST-MODULE EXPERIENCES

Few of our teacher candidates (TCs) have experienced PBL as learners. Thus, before assigning the module, we have them participate in a PBL experience as though they were elementary or secondary students. The PBL experience varies in methods classes but "Bears in a Boat" (Rillero, Thibault, Merritt, & Jimenez-Silva, 2018) is often used in the elementary course and PBL with pendulums (Rillero & Hernandez, 2016) is frequently used in the secondary course.

After the module, TCs have experiences designing and implementing PBL in our methods courses, in subsequent methods courses, and during their student teaching. Our sequences of experiences are presented in Figure 1.

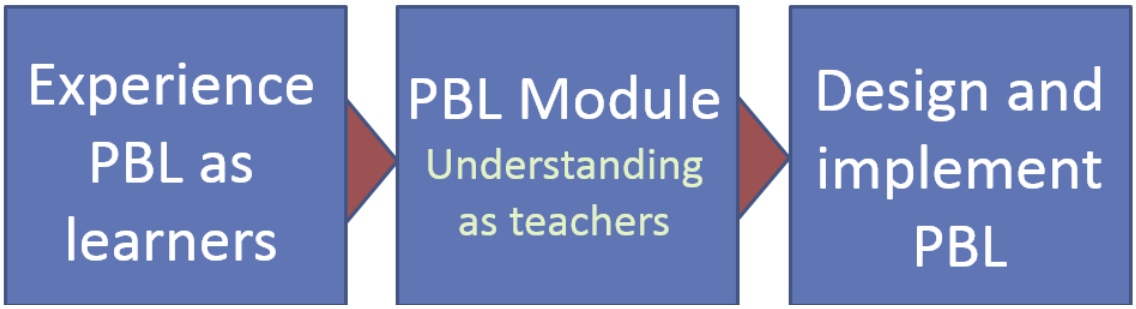

Figure 1. The module in context of other PBL experiences.

METHODS CLASS EVALUATION OF MODULE

Instrument and Populations

The following sources of data provided insights into TCs' perceptions of the module: (a) a survey administered shortly after the module completion and (b) interviews with selected students. The survey consisted of 16 Likert items and two opened-ended questions. Each Likert item is rated using a 1 (strongly disagree) to 5 (strongly agree). The two open-ended items were as follows:

(A) What are the best aspects of this module? Please say why these are good

(B) What aspects of the module could be improved? Please say why.

We also conducted in-depth, semi-structured, clinical interviews (Patton, 2001) to elicit students' inner opinions toward the digital PBL module. Three students were randomly selected for the interviews. Each student was interviewed individually by the second author. The length of interview time was approximately thirty minutes. The semi-structured interviews served a means to triangulate data from two open-ended questions and the sixteen Likert items. Thus, the interviews focused on confirming or disconfirming participants' responses for the instrument and two open-ended questions.

We administered the survey to 62 TCs (preservice teachers) after module completion. The reliability based on Cronbach's alpha coefficients is 0.76, suggesting that the items have acceptable internal consistency.

Quantitative Results

The average age of participants is 23.92 years old, ranging from 20-42. Gender, course, and desired teaching level are presented in Table 1. The average total score for the 16 items is 64.5, ranging from 47 to 80. The average item score is 4.03 (SD=0.80). The lowest means (reported with SDs) were for the following two items: "The module challenged me to do my best work" (3.72, 1.05) and "The module was interesting" (3.76,

0.92). The highest means were for "The module was relevant for my future work" (4.55, 0.56) and "The module design was clear and coherent" (4.45, 0.56). The average time reported to complete the PBL module is 45.24 minutes, ranging from 10 minutes to 80 minutes. The mean scores and standard deviation for each subgroup are shown in Table 2.

Sample demographics: Participants' Gender, Course Taking, and Desired Teaching Level

Category	Sub-category	N	%
Gender	Female	50	80.6
	Male	12	19.4
Course	Elementary education undergraduate preservice teachers	24	38.7
	Elementary Special Education undergraduate preservice teachers	13	21
	Elementary education graduate preservice teachers	5	8.1
	Secondary Education science preservice teachers	20	32.2
Desired teaching level	Early elementary (k-3)	25	40.3
	Upper-level elementary (4-6)	8	12.9
	Middle school (7-9)	14	22.6
	High School (10-12)	15	24.2
Course level I	Elementary	42	67.7
	Secondary	20	32.3
Course level II	Undergraduate	57	91.9
	Graduate	5	8.1
Total		62	100

Table 1

Sample Sizes, Mean Scores, and Standard Deviation for each Subgroup

Group		N	M	SD
Total		62	64.50	8.89
Gender	Female	50	65.00	8.64
	Male	12	62.42	10.00
Course Level I	Elementary	42	66.42	8.42
	Secondary	20	60.45	8.67
Course Level II	Undergraduate	57	63.61	8.61
	Graduate	5	74.60	5.22

Table 2

Comparing Groups on Quantitative Survey

A one-way analysis of variance (ANOVA) was conducted to analyze potential differences between sub-groups. Scores on the questionnaire were used as the dependent variable,

with the sub-group as the independent variable. The statistical significance was determined at an alpha level of .05 for all statistical tests.

Results showed no significant difference between gender even though females rated the module slightly higher than males. Results showed that TCs who took elementary level courses had significantly higher rating than secondary level courses, $F(1, 61)=6.699$, $p < .05$. *Post hoc analysis* showed that Item 1 (The module learning outcomes were clear), 3 (The learning and teaching methods used were effective), 5 (The module challenged me to do my best work), 6 (The module increased my understanding of the topic), 7 (The module encouraged me to feel part of a community committed to learning), 12 (The module was relevant for my future work), 13 (The module was interesting), and 15 (My interests in the subject has increased as a consequence of this module) had significantly higher scores for the TCs in elementary level courses

Results showed that graduate TCs rated significantly higher than undergraduate students, $F(1, 61)=7.802$, $p < .01$. *Post hoc analysis* showed that Item 2 (The module design was clear and coherent); 4 (The workload for this module was reasonable), 5 (The module challenged me to do my best work), 6 (The module increased my understanding of the topic), 7 (The module encouraged me to feel part of a community committed to learning), 8 (The module met my expectations), and 13 (The module was interesting) had significantly higher scores in the group of graduate students.

As a comparison group, we also had experienced, certified teachers in a two-year old Science, Technology, Engineering, Art, and Mathematics (STEAM) compete the module and survey. There were nine teachers in this sample. The rationale for this comparison is that inservice teachers with their education and experience may better understand the value of teacher education tools. Results showed that inservice teachers had significantly higher scores than preservice teachers, $F(1, 70)=3.854$, $p < .05$. *Post hoc analysis* showed that Items 4, 8, and 13 had significantly higher scores in the group of inservice teachers.

Open-ended Questions & Semi-structured, Clinical Interviews

Constant comparative method (Strauss & Corbin, 1990) was utilized to identify regularities or patterns in the two open-ended questions from 62 students and semi-structured, clinical interviews from three students. Data analysis involved an iterative process of coding, displaying, reduction, verification, confirmation, and disconfirmation of data. The initial coding scheme was organized around two categories of students' perceptions of the PBL module and the potential ways to improve the PBL module. Within the two categories, additional sub-codes were employed to capture students' perceptions and opinions after they completed the exploration of the module. Patterns and themes emerging from the data were discussed and refined using investigator

triangulation (Janesick, 1994). This process continued until major themes had been substantiated and refined.

Data analysis revealed six salient features of the use of PBL module. Features 1-3, shown in Table 3 are related to module effectiveness. Feature 4-6, shown in Table 4 are addressed the potential ways to improve the PBL module.

Effectiveness of the PBL Module

Feature 1: This module is concise and organized
Evidence from open-ended questions *-The layout is easy to follow, professional looking. AND the questions (a couple of) them were tricky so I felt as if I really needed to pay attention. It made me think!* *-The information is well structured making it easy to follow.* **Evidence from interview** *-I really liked how it was structured. I think it's a good practice and a good way to learn about the problem based learning.*
Feature 2: This module provides effective and practical examples to understand the implementation of PBL
Evidence from open-ended questions *-The scenarios provided practical examples connecting the concepts to classroom situations* *-It gives really good examples. I also liked how they incorporated actual teachers who have used this strategy and talked about how effective it is in their classroom.* **Evidence from interview** *-It's very sequential; we talk about different sections of it, and it gives really good examples.*
Feature 3: This module provides interactive and rigorous videos to engage learners
Evidence from open-ended questions *-The module was interactive. It asks me questions to check for understanding, which helps a lot. Input from professional in the field real world explanation.* *-Expert opinion videos, examples and elaborations on each topic, interactive questioning.* **Evidence from interview** *-I also liked how they incorporated actual teachers who have used this strategy and talked about how effective it is in their classroom.*

Table 3

Ways to Improve the PBL Module

Feature 4: Operational process can be improved, such as information seeking, back to previous learning portfolio
Evidence from open-ended questions *-I did not like that it was difficult to go back and find information.* *-Might there be an opportunity to go back into the module, while taking the test?* *- It didn't give an explanation when you selected an incorrect answer. It just said, "Incorrect."* **Evidence from interview** *- I think that I have to go back and watch the module again to be a little more clear on it. I mean I think the information was good, it's just when I went to answer the assessment I just didn't perform well. Maybe going back and watching the module again would be more helpful.*
Feature 5: More examples and opinions at/ from different grade levels and teachers
Evidence from open-ended questions *-I think there should have been more examples in all different types of science content and at different grade levels.* *-Making is more related to secondary ed. The examples were mostly around elementary science so it is not as relatable for secondary education teacher.* **Evidence from interview** *-I put my reflection was just having more content examples specific to my content, specific to my area, like secondary education, high school, kind of examples.*
Feature 6: Combine with sequential lessons to implement and design a PBL lesson
Evidence from open-ended questions *-I think that the whole PBL method is good but I think it would help to show what the entire process looks like in the classroom as an example of each step so the view can see a visual.* **Evidence from interview** *-I think that's a good way to introduce it. Then now you can dissect what each part looks like, show examples of lesson plans, and then actually have students make the lesson instead of the other way around, because I know we're doing it other sorts of classes.*

Table 4

DISCUSSION

TCs views of the PBL module are positive. For the 16-item survey, the mean score is 4.03 out of five. The highest evaluated item, relevancy for future work, is noteworthy, as our TCs do not always see the relevance of what they are learning. The second highest rated item was for the module design being clear and coherent. This may be due to the long and

detailed process in the module development (Rillero & Camposeco, 2018) and is also reflected in the open-ended and interview responses of TCs. While all survey items were rated above the midpoint (three for the five-point scale), the lowest rated item was "The module challenged me to do my best work." Striking the balance between frustration and challenge can be difficult to achieve for all students; the results suggest that some students might benefit from a higher challenge level. The second lowest rating was for "The module was interesting." Future iterations of the module should strive for greater levels of interest.

TCs in elementary methods courses rated the module higher than TCs in our secondary education courses. Although there are different path options in the module, the main PBL described was for lower elementary students. This might have been a factor in the lower scores by secondary education students, which was suggested in the open-ended comments. Module revision should incorporate more secondary education options. The graduate students rated the module higher than undergraduate students. The reason for this is not clear but presumably their previous education and life experiences contributed to this higher evaluation score.

Experienced inservice teachers, in the second-year teaching in a district STEAM program, also completed the module and survey. This group rated the module significantly higher than the preservice teachers. The higher ranking by experienced teachers lends credibility to the module. The reasons for the higher ranking could be explored in future studies.

The PBL module is a start to enable future teachers to implement the method. We also engage students in a PBELL experience (Rillero, Thibault, Merritt, & Jimenez-Silva, 2018) and synergy between the module and the experience, leads to high-quality TC work as they develop and implement PBELL experiences. By focusing on PBL with language supports the preservice teachers develop abilities to make the experiences more beneficial for all students but especially ELLs.

CONCLUSION

The PBL module is used in our science methods courses as part of a comprehensive method for enabling future teachers to have the knowledge, skills, and mindsets to implement PBL. The module describes the benefits of PBL, steps for implementation, tips for getting started, and presents a rich description of a PBL experience. An assessment at the end synthesizes and evaluates learning. A certificate earned is presented as proof of completion. Our TCs generally have positive views of the module. Prior to

learning from the module, the TCs experience PBL as though they were an elementary or secondary student. After the module, students have experiences designing and implementing PBL in their internship classrooms.

Acknowledgments

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Problem-based Learning in a Box: Lessons learned from an Educational Design Experiment

*Jacob Davidsen, Pernille Viktoria Kathja Andersen and Ellen Christiansen **

ABSTRACT

In this study, we present an educational design experiment seeking to promote interaction and knowledge sharing in groups and to establish a sense of community among students during a semester at Aalborg University, Denmark. The experiment is materialised as a tangible artefact in the form of a colourful box with materials and texts. Some of the materials are oriented towards supporting the collaborative activities taking place in the group, while others are intended to support individual groups in displaying a visual identity and the public historical trajectory of their problem-based learning process to other groups or peers. The lessons learned from the experiment highlight that educational designs are difficult to implement in practice if it is not mandatory for the students, teachers and supervisors to take part. Furthermore, we imagined the box as a toolbox to support process-related aspects of problem-based learning, such as collaborative interaction, problem formulation and the collaborative learning process itself, whereas the students requested specific 'how to' materials for certain project activities – focusing more on the semester product and the outcome of problem-based learning.

INTRODUCTION

At Aalborg University (AAU) in Denmark, the overall philosophy and pedagogy is based on problem-based learning (PBL) (Holgaard, Ryberg, Stegeager, Stentoft, & Thomassen, 2014; Kolmos, Fink, & Krogh, 2004). In the literature, PBL is highlighted as a pedagogical model supporting students in obtaining transversal competencies such as collaboration, communication, critical thinking and problem-solving skills (Du, Emmersen, Toft, & Sun, 2013; Guerra, Ulseth, Jonhson, & Kolmos, 2017). To teach students about PBL on a theoretical, methodological and practical level, there is a

* Jacob Davidsen, Department of Communication and Psychology, Aalborg University
Email: jdavidsen@hum.aau.dk
Pernille Viktoria Kathja Andersen, Department of Communication and Psychology, Aalborg University
Email: pvka@hum.aau.dk
Ellen Christiansen, Department of Communication and Psychology, Aalborg University
Email: ech@hum.aau.dk

mandatory introductory course in the first semester in most educational programmes at AAU. Across the different educational programmes, this course is designed to meet the demands of the individual scientific discipline, while still adhering to the overall principles of AAU-PBL (Askehave, Linnemann Prehn, Pedersen, & Thorsø Pedersen, 2016). These principles are:

- The problem as the starting point
- Project organisation creates the framework of PBL
- Courses support the project work
- Cooperation is a driving force in problem-based project work
- The problem-based project work of the groups must be exemplary
- The students are responsible for their own learning achievements

In many ways, this introductory course is supposed to give students the necessary competencies and skills to study on the basis of the PBL principles, while also setting the stage for the continuous development of this way of studying throughout their education. Although many of the new students already have experience with collaboration and project work from their previous educational training, the AAU-PBL way of studying is different and the students have to learn how to learn this way. A key difference is that the students will be familiar with short-term projects in which the teacher designs a problem, whereas the students at AAU have to work together independently for 3–4 months on identifying, addressing and solving a problem while supported by a supervisor.

Besides the introductory course on PBL, the students are supervised by a teacher/researcher in their semester project. As illustrated in Figure 1, PBL supervision should be directed towards both the product (the text or design) and the process (e.g. how to manage collaboration, address and identify problems, etc.) (Dahl, 2008).

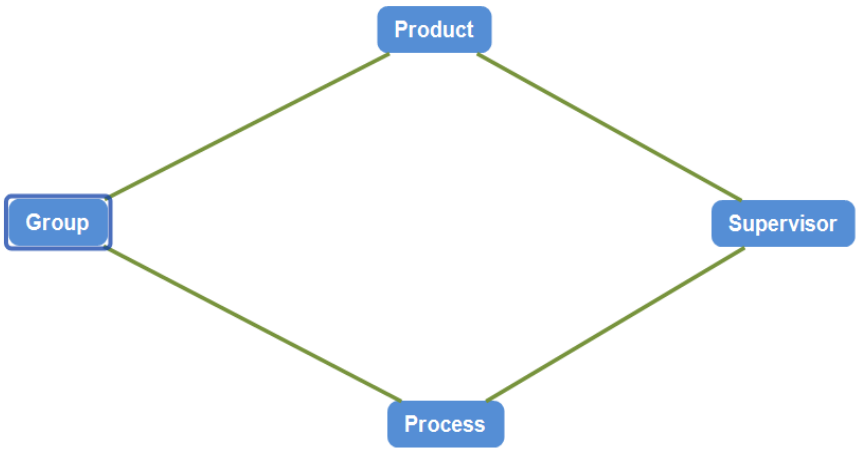

Figure 1. Relations between group and supervisor

In this case, we focus on PBL in the educational programme of Communication and Digital Media (CDM). This programme admits 100 new students every year, who will have to learn how to learn in the AAU-PBL way. The overall learning objective of the PBL course is to introduce new students to the core principles of PBL, as well as to scaffold students in how to integrate these principles into their own study practices. Through a seven-week course programme in 2017, the students were introduced to the following PBL-related themes: 'study technique: reading', 'project group collaboration', 'planning and process', 'problems and problem formulations', 'study technique: academic writing', 'information seeking' and 'PBL and IT'. Each week, a new theme was unfolded through a combination of 1) a lecture introducing the theme, 2) a workshop integrating the theme into group discussions, 3) written reflection papers reporting group discussions and 4) oral feedback sessions with teachers and other students reflecting on a written paper. Halfway through the course, a PBL box was handed out to the groups (see in detail below). In addition, the groups had to participate in two seminars with other groups and different supervisors, first presenting and discussing their problem formulation and then their strategy for conducting a literature search. In terms of supervision in the semester project on the CDM programme, the supervisor is expected to deal with both product- and process-related issues. As it, the attention of both students and supervisors is primarily directed towards the product being embodied as a text, backgrounding the process-related aspects of supervision in many cases. With our design experiment, we also wanted to support the students and supervisors in focusing more on the process-related aspects of PBL.

THE DESIGN EXPERIMENT

The design experiment was based on pedagogical experiments carried out in recent years in which teachers from the CDM programme have tried different designs for teaching PBL. Davidsen and Ryberg (2016) have explored how digital media (Google+) can support interaction and knowledge sharing and can establish a sense of community among students. One of the primary ideas of the design experiment was to make the work of the individual student group publicly available to the entire semester class – for inspiration and criticism. With these experiences in mind, we wanted to explore ways of supporting interaction, knowledge sharing and a sense of community in physical space by introducing a PBL box. In the year 2017, the Department of Communication and Psychology (approximately 100 students and 20 student groups) moved to a remodelled facility. We were given the opportunity to design a new learning space and explore the affordances of a PBL box (Figure 2). Basically, we wanted to support the students in developing a PBL way of studying and by making the product and process of their project more visible to fellow students and their respective supervisors.

Figure 2. The PBL box

Our goal in this experiment was to explore how to support the students in attending to process-related aspects of PBL with a box full of materials. Our hope was that this would eventually lead to a shared practice and a higher level of reflection on how to manage and adopt PBL practices. In essence, we wanted to support a transition from individual to collective forms of externalising knowledge, both within the individual groups and between the groups in the semester, and to cultivate hybrid practices rather than solely digital or analogue.

As the case format of the journal offers a limited number of characters, we only present some of the theoretical assumptions guiding us in designing the box as a materialisation of the pedagogical support material we wanted to introduce. Lefebvre (2011) has formulated the interwoven relationship between knowing, expression, material and the senses, which indicate that learning and development are not only a matter of learning to master words but also a matter of exploring and using materials to stimulate expression and reflection at some point: '[T]here can be no thought, no reflection, without language, and **no language without a material underpinning** – without the senses, without mouths and ears, without the disturbance of masses of air, without voices and the emission of articulated signs' (Lefebvre, 2011, p. 402, highlighted by author). Furthermore, the idea was for the box and materials to serve as a boundary object in the sense described by Star and Griesemer (1989): 'plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites' (p. 393). In order to serve as a boundary object, the box and materials were designed as a conspicuous 'thing' intended to stimulate interaction and knowledge sharing within and outside the group, and to establish a sense of community among the groups, with each group having its own box.

The boxes were handed out to the students after they had formed their groups for the first-semester project (approximately one month into the semester); at the same time, the groups were expected to find their place in the physical learning environment. Our initial idea was that the box and the materials would not be introduced with a step-by-step guide for the students, because we wanted to see how the students used and adopted the box and materials in their practice on their own. In other words, we did not want to impose a specific way of using the box on the students; rather, we wanted to see how the students used the box independently. Initially, the students started unpacking the contents of the box and many groups decorated their learning space with the materials (Figure 3).

Figure 3. Students decorating their room with materials from the box

UNWRAPPING THE PBL BOX[1]

Creating a visual identity and public trajectory for the PBL group process

As the first-semester students had been allocated dedicated group learning spaces for their group work, we wanted to support them in making their work, ideas and frustrations public to the rest of the class. Thus, we designed two A0 posters:

[1] Download the materials in the supplementary files (in Danish).

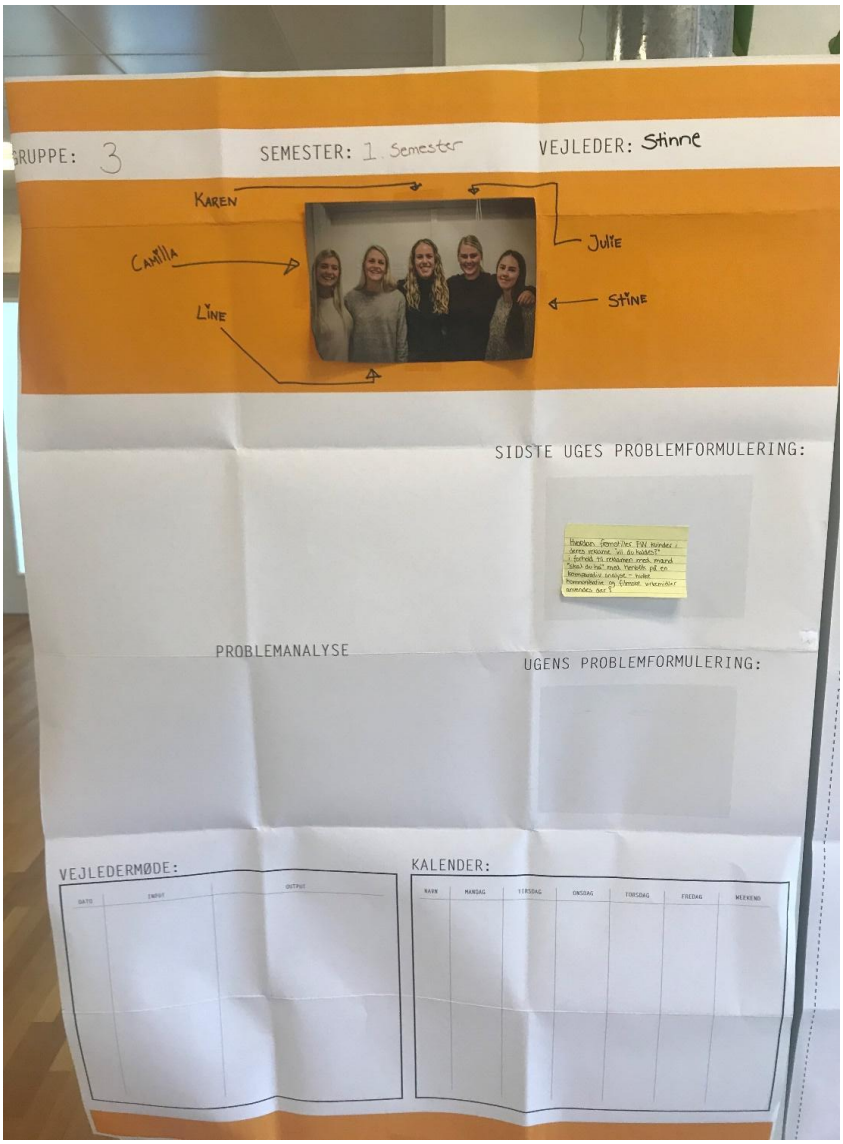

Figure 4. Poster 1 from group 3

With the first poster, we wanted to create a visible group identity, with the students adding photos of the individual group members in the orange field and identifying their group number, semester and supervisor. Furthermore, to indicate the importance of nurturing and cultivating re-formulations of the problem, we added three fields: 'Problem analysis', 'Last week's problem statement' and 'This week's problem statement'. Our idea was to support the students in developing a history of their work with the problem, which could be discussed continually with their supervisor and included in their final project report. In the final section of the poster, we added calendars to illustrate the importance of planning the process and keeping track of the outcomes of the meetings with the supervisor.

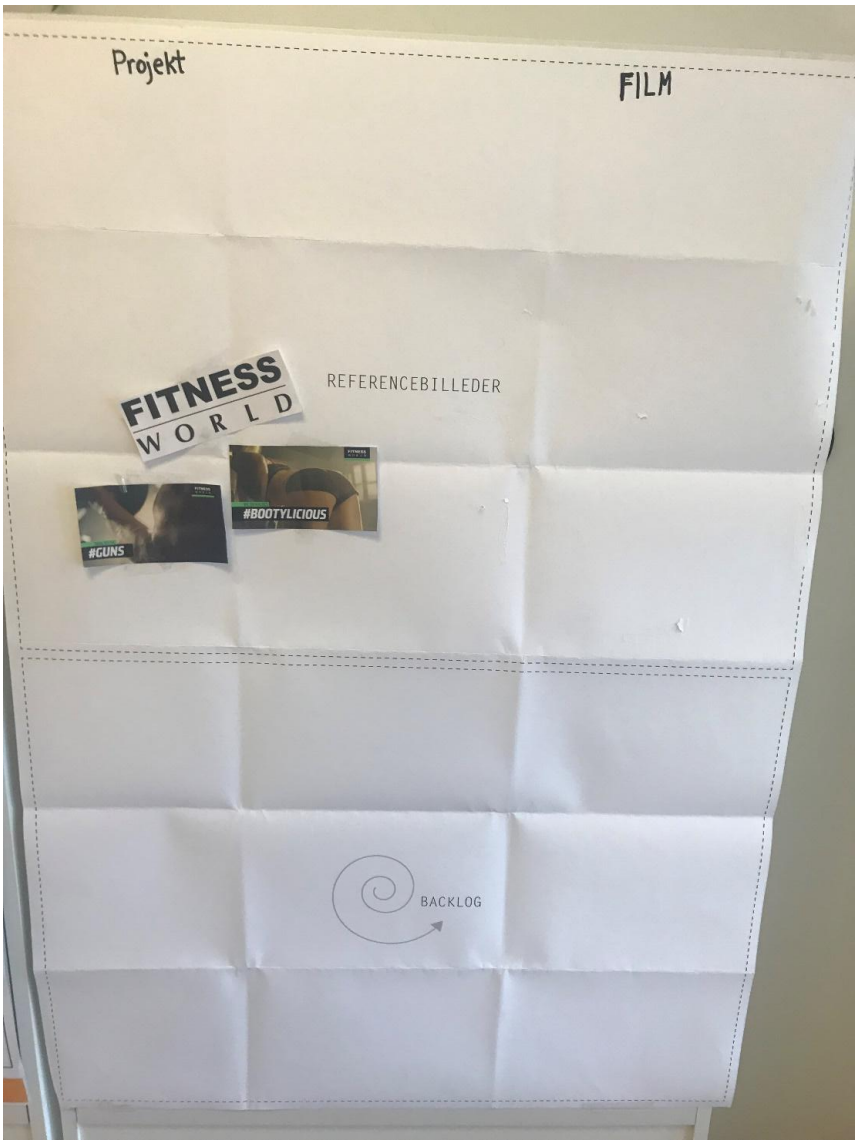

Figure 5. Poster 2 by group 3

The second poster was more like a blank canvas for the students to pin up their references and ideas, such as photos of books, products, models, etc. Basically, we wanted the students to add all relevant content to the canvas to support their collective memory, but also to showcase their process to their supervisor and fellow students. Finally, we added a section called 'backlog', which was intended to allow the students to revisit their earlier ideas or writings at a later point in their project, simply to keep track of things. This was inspired by SCRUM (Schwaber & Beedle, 2002), which is used as an established method for conducting work processes in software development projects.

Supporting collaborative processes

To support some of the various PBL activities and phases, we designed 12 cue cards describing ways of dealing with different aspects of PBL:

- Problem analysis
- Learning goals as points of orientation
- Feedback – how?
- How to get ideas
- Academic writing
- We are lost – what to do?
- Evaluating a group meeting
- Matching expectations
- Project management
- Types of supervision
- Roles in the project group
- Collaboration

The cards can be divided into three themes: 'how to' instructions, relevant information and reflection. The idea of giving the students a series of cards was to promote support at the right point in time instead of presenting the resources in PowerPoints or textbooks. In addition, we added an hourglass and six Lego™ figures, the latter to support the students in trying out different roles (e.g. Belbin's [2010] team roles) and the former to make visible to the group the division between social time and project time. Finally, we included a print of the official PBL folder describing the principles of AAU-PBL.

Diagram of a project

To illustrate the chaotic and non-linear nature of a PBL project, we designed a diagram (a spaghetti model) of a project period showing the different lines/trajectories (Ingold, 2015) in a project (e.g. method, problem formulation, data, literature and theory). This way of illustrating a project further resembles the nature of SCRUM (Schwaber & Beedle, 2002), instead of the more linear ways of illustrating a project (e.g. a step-by-step-guide).

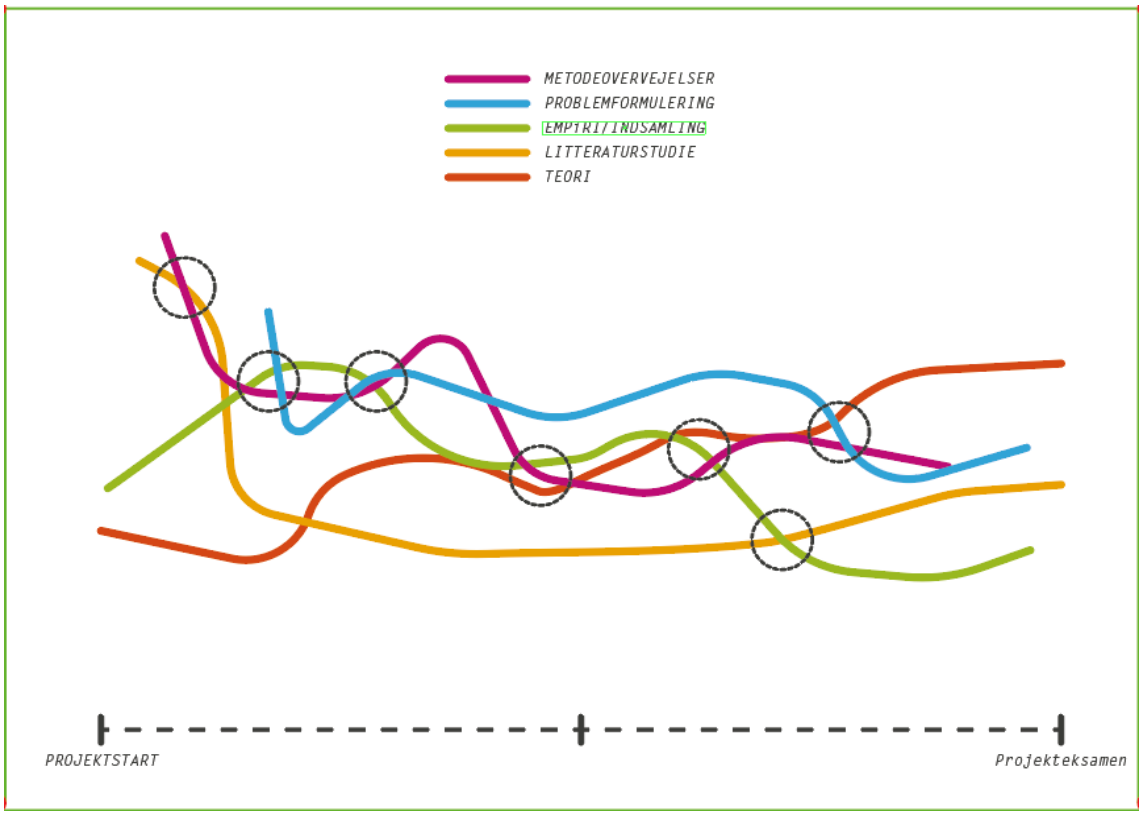

Figure 6. The spahetti model

LESSONS LEARNED: STUDENTS' USE OF THE PBL BOX

To follow up on the use and adaptation of the box and materials, we observed and interviewed five out of 20 student groups throughout the semester; subsequently, we also invited all of the students to a workshop with the purpose of evaluating the box. Eight students out of 95 volunteered to participate in the workshop, which was video recorded for documentation purposes. During our informal visits throughout the semester, we observed that many of the student groups did not use the box or materials to support their work; for example, their posters were not filled out and the box was placed on a shelf in the group space. For this presentation of outcomes, we have divided our observations from the workshops into five themes: practicalities; further introduction needed; no obligations, no use; analogue vs. digital practices; and other resources. We suggest that these themes must be addressed and dealt with in future implementations of the PBL box and its pedagogical content.

Practicalities

Some of the first things to notice with regard to the use of the box and materials are some practical obstacles: the posters would not stick to the wall and the students did not have

any pencils to write text on the posters. Consequently, most of the student groups ended up never filling out any of the information on the posters. They would have liked post-its and pencils above anything else in the box.

Further introduction needed

The students reported that, at first, they were happy about the box and thought it would become a useful resource in their project work. They explained, however, that they forgot about the box and materials a couple of days after they had received it. Some of the students said it was too overwhelming and that they did not know how to use the materials. They would have liked a more systematic introduction to the materials to make better use of them. On the other hand, some of the students described the materials as too pedagogical; for example, they did not need an hourglass as a symbol of social and academic time.

No obligations, no use

None of the student groups talked with their supervisor about the contents of the box, nor did they use the posters to make visible the progress and process of their project to the other groups. This is actually not surprising; we have witnessed a close relationship between students' engagement in 'must do' and 'can do' assignments in our previous work (Davidsen & Ryberg, 2016).

Analogue vs. digital practices

In the workshops, the students also reported that they transferred some of the analogue materials to digital platforms; for example, the backlog, the calendar and the problem statement were re-mediated into Google Docs. Thus, they used tools and resources other than those provided in material form in the box, while in fact appreciating the ideas of the pedagogical tools.

Other resources

Interestingly, the students would have liked other materials to have been included in the box – they suggested more recipe-like materials, such as how to perform a structured search in the university library databases, how to reference correctly, a template for a group contracts, etc. As one of the participants said, 'These would be tools for the real project work' (student 1, group 2). It seems that the students were looking for tools to support very specific activities in their project work, whereas our original idea was to support students' collaborative reflexive practices by introducing materials into their practices of learning and doing PBL. Hence, there appears to be a tension between our

view of the process-related aspects of PBL and the students' view; whereas we strived to support reflection on the PBL process, the students wanted 1–1 descriptions of tasks related to their project work.

FUTURE DEVELOPMENTS

In this final section, we reflect on what could be done in a new design experiment based on the lessons learned from the present one:

Better linking between course activities and the PBL box

- Instead of giving the groups all the materials at the beginning, we might introduce the different materials piecemeal as part of the introduction to the 7 PBL-related themes (see p. 3) of our teaching throughout the semester. This could provide a better connection between the course activities, the contents in the box and the specific challenges the students face at the right point in time. It may also help to overcome the 'must do' and 'can do' problem of students' engagement.

Better support for students' development of PBL process skills

- We have realised that the toolbox in itself does not support the students in developing PBL process skills. In addition, we have learned that the students prefer supervision on their product (text), and that they do not necessarily feel a need to discuss process-related issues with their supervisor. In relation to this, it seems that the supervisor plays an important role in 'legitimating' or downplaying the importance of different PBL-related issues.
- In any future experiment, it may be worth considering 'investment' in process-related supervision, in combination with the traditional product supervision. It could be of pedagogical interest to train a group of supervisors in facilitating PBL processes among students. This could involve integrating the content of the PBL box into supervision activities.

Better alignment between pedagogical beliefs and students' practice

- As we have shown, it seems that our pedagogical beliefs about relevant materials are not aligned with the students' practice and current understanding of PBL. To strengthen the idea of enhancing interaction, knowledge sharing and community building in the physical space, more research is needed. This would need to include research into the specificities of first-semester students' preferences and ways of working. For instance, we have reported how the students themselves transferred analogue materials onto digital platforms, and in relation to this we

need additional insights into the different preferences and needs regarding digital and analogue support for the PBL process.

From this design experiment, we have learned that it takes more than a box and materials to change the behaviour and attitude of first-year students and get them focusing on their PBL process. We would need to integrate pedagogical activities into the introduction of the box and work closer with the supervisors to align our activities and efforts. The fact that students seek product supervision first is understandable, but it just emphasises the importance of giving the PBL process supervision another form. Thus, our experiences have led us to consider materials and activities that can mediate both product and process supervision from students' and supervisors' perspectives. Furthermore, it is clear that future projects need to include activities that involve the supervisors. These could align the pedagogical ideas of the box and materials with the practice of the individual supervisor.

FINAL COMMENTS

During the project, we were met with enthusiastic comments from university colleagues and study councillors – they were all thrilled about the box and some wanted copies. While we appreciate all the positive feedback, we want to offer a critical voice based on our experiences: it takes more than a box to introduce and vitalise PBL among first-year students (and supervisors); this is an observation that calls for discussion of PBL, learning, tools and pedagogy among teachers and supervisors. In short, this experiment has taught us that there is no quick fix (analogue or digital) for changing learning in Higher Education and we hope that this case can act as a catalyst for further discussion about future directions in teaching PBL at AAU.

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Scaffolding in PBL: A Case-study in Facilitated Soft Skill-set Learning amongst Adult Learners in Taiwan's Vocational Higher Education

Sabrina Chia Jung Lee *

ABSTRACT

Taiwan's university-level vocational education is faced with a growing need to strengthen students' soft skills as a means to increase job market eligibility. Students in Taiwan are usually not equipped with group learning skills in junior and senior high school education. These learning skills, however, are an essential component of a successful PBL course, according to past research. This case study describes how a PBL course that adopted various scaffolding strategies helped vocational students improve soft skills associated with real-life issues in the workplace. The adult learners participating in the tailored PBL course were PBL novices, yet their feedback on PBL effectiveness was positive. The success of the PBL course was attributed to 1) the use of effective scaffolding strategies, and 2) learner readiness in the skills needed for group learning.

INTRODUCTION

Problem-based learning (PBL) has been increasingly adopted by Taiwan's Institutes of Technology (IOT)[1]. In response to job market requirements, from the late 2000s, the Ministry of Education (MOE) initiated a programme of project-based funding aimed at encouraging both public and private IOTs at the university level to adopt PBL for soft skills training. An issue encountered by many IOTs was the lack of faculty able to implement PBL. Moreover, Taiwan's junior and senior high school education, similar to many other Asian countries, focuses more on tests and professional training as opposed to equipping students with effective soft skills, such as team-work or interpersonal skills.

[1] In Taiwan, these IOTs include Colleges of Technology and Universities of Science and Technology.

* Sabrina Chia Jung Lee, General Education Centre, University of Taipei
Email: nccu.sabrina@gmail.com

Therefore, in the mid-2010s, the MOE launched a project to fund IOTs to implement PBL in general education. General education refers here to a set of curricula in higher education that typically includes the competencies, skills, and qualities that students must know or acquire to meet the demands that the future will place on them. The MOE encouraged IOTs to recruit professional external PBL trainers outside the IOT system with the aim of achieving more properly implemented PBL courses. The case study highlighted here was funded by the MOE PBL-Project and implemented for a single academic term (from year 2017 to 2018) by trainers outside of the IOT system.

The PBL course took place in a private technological college of approximately 1,200 students. Class-time of 2 hours weekly for one academic term was required of students in order to pass the 2-credit course.

The class had funding for one main lecturer and one supporting lecturer, and both needed to assume the role of a facilitator on various occasions, particularly in the case of small group discussions. This course, 'Journey to the West[2]: Career development and problem solving', had the aim of helping to prepare students to solve complex managerial problems in the workplace. The objectives for the course were to (1) improve students' critical thinking skills, (2) improve students' problem-solving skills, and, (3) help students find better solutions for managerial problems in the workplace.

RESEARCH ON MEASURES TO ENHANCE PBL

Camp (1996) suggests that PBL is based on a foundation of collaboration and integration within a small group context. The effectiveness of PBL is impacted by how well students work together (Peterson, 1997). Past research has shown that the 'necessary' skills for PBL course participants include: consensual decision making skills, dialogue and discussion skills, team maintenance skills, conflict management skills and team leadership skills (Johnson & Johnson, 2014). As most of these are higher-order thinking skills, successful cases of PBL implementation most often occur in the context of advanced education, such as medical or legal education (Hmelo-Sliver, 2004; Polanco, Calderón & Dalgado, 2004). Yet recent research has revealed that low-achieving learners can also benefit from PBL through scaffolding or an integrated PBL approach (Hamidah & Yuriani, 2015; Haruehansawasin & Kiattikomol, 2018). Hamidah and Yuriani's integrated PBL approach provides a model for nurturing soft skills of higher-order thinking in vocational students (Hamidah & Yuriani, 2015). The research of Haruehansawasin and Kiattikomol also targeted learners in vocational schools,

[2]*Journey to the West* is a famous Chinese novel published in the 16th century. Nowadays, the book has gained renown for its ability to shed light on managerial problems in the work place.

concluding that using suitable scaffolding approaches for low achievers was critical in PBL.

IMPLEMENTATION: STUDENTS' BACKGROUND

The PBL class consisted of 35 freshmen and sophomore students from the same department. According to student feedback, they were all PBL novices, at least that is the college had yet to provide similar courses of instruction. Students in this class were all adults, whose working experiences ranged from 3 to 30 years. The lecturers also confirmed that many students had been salon managers or sole-proprietors. These past experiences had equipped them with mature interpersonal skills, which are the group learning foundation for a PBL course. Even though some younger learners had less working experience than the managers in class, those who had been managers could fill the role of a team leader and facilitate group discussions. In other words, the composition of such a learning group provided suitable grounds for fruitful small group discussions; and consensus could be built in problem solving simulations through discourse. Below is a brief description of the learning group:

- 35 students. (Male:8; Female:27)
- Work experience: ranging from 3-30 years, but most of the students had more than 10 years of experience working.
- Class make-up: students were all either freshmen or sophomores from the department of Fashionable Hair, Nail and Overall Image Design.
- Students were enrolled in the higher vocational education 2-year Diploma Programme.

Since the groups of adult learners were equipped with higher levels of interpersonal skills than those of most young vocational students, PBL was an appropriate approach to facilitate students' learning. In order to further scaffold students' learning, the course made use of a set of well-designed classroom activities, tasks and homework assignments, which required students' full participation.

THE DESIGN OF THE PBL COURSE

The aim of the course was to help students improve their soft skills and become more successful in their careers. The teaching strategy consisted of textbook readings which provided the basis of problem-solving resources for in-class discussions on career-oriented problems or issues. Furthermore, students were required to share their own working experiences with the class and brainstorm about commonly encountered

problems or issues in the workplace. The textbook selected for the course covered the following topics:

- How to be a good team player? How to lead a team?
- How to place the right person in the right position at the right time on a team?
- How to get trailblazers to play by the rules at work?
- How to keep pace with workplace ethics?
- How to overcome stress or dejection caused by work?
- How to deal with conflicts at work?
- How to build up good public relations?
- How to be successful in a career?

Students' own career issues/problems in their job field were also covered, such as:

- Issues of employees' tardiness at work.
- How to evaluate a hair designer's work performance and set equitable commission percentages on the basis of performance?
- How to set up and reinforce open communication platforms between the boss and the staff?
- How to boost employees' morale and get them more engaged in their work?

SCAFFOLDING STRATEGIES IN PBL

Schmidt, Rotgans and Yew (2011) provide an explanation of how soft scaffolds offer dynamic support, which includes conversations between lecturers and learners or among leaners themselves during the learning process. Soft scaffolds also involve learners collaborating at various performance levels and working in small groups to accomplish particular tasks throughout the learning process (Nussbaum et al., 2009). There are also hard scaffolds, which include the static supports or tools that are developed in advance to guide learners during the learning process. Due to limits on time and resources, the scaffolding strategies utilized in this case were all soft scaffolds. Furthermore, lectures made up part of each week's class to ensure that students were clear about weekly themes and learning targets. In the first few weeks of the class, the lecturers focused on students understanding of their responsibilities for learning in a PBL environment. These included formal talks in class or small talks with students during breaks.

A. Required textbook reading and worksheets writing

A textbook was selected as required reading for the course. Not only were learners required to read nearly every chapter of the book, they also had to answer open-ended questions from a worksheet that was provided to them each week (no more than two A4-

size pages in length). Worksheet questions reviewed the week's chapter and linked readings to the relevant learning topic, such as (to name only a few):

- The summary of the chapter.
- What are the key rules for career success from the author's point of view?
- How do you identify yourself with the character in the story of Journey to the West?
- How would you retell part of this story to link it to this week's theme?
- Do you think X (e.g. personality, public relations, teams, etc..) is important in career building? Why or why not?

B. Small group tasks

Small group tasks were another important scaffolding strategy in this course. Different members of small groups were formed into special task groups so that learners had the chance to work with other students with whom they had not been previously grouped. Some of the tasks were designed to break the ice; others to facilitate students' group learning. In the first 2-4 weeks of class, students were grouped with course mates with whom they were familiar. From week 5-8, students were grouped with course mates with whom they were not familiar. The strategy was to have students work with others in completing a given task. These group activities or in-class tasks were done for the purpose of building up consensus in problem-solving through shared experience and brainstorming. Here, the constructivist approach could be implemented owing to the focus on interactive discussion-based learning that used a set of topics highly relevant to learners' experiences in the workplace.

C. Facilitators' input in students' problem-solving processes

Even though these adult learners were mature group learners, it was still difficult for them to 'state the problems' clearly, as they were never trained to analyse an issue or a problem. Therefore, from week 10-12, the lecturers played a more active role as a facilitator by guiding each group in defining their problem and giving a clear statement on the problem they wished to solve. Lectures provided examples of problem-solving models as well as instruction in a 9-step problem-solving method (also some concrete examples) to guide each group in step-by-step analysis and brainstorming. From week 13-15, each group started to work on their own problem solutions based on shared experiences, or group discussions and consensus. Students were also encouraged to use 'figures, charts or tables' as persuasive aids in the completion of a problem-solving handbook. In the final stage of the class, each group presented their selected problem or issue and then simulated the problem-solving process as a demonstration of PBL learning outcomes.

In correspondence with the above overview of a weekly class, the following table shows the scaffolding strategies employed at different stages of this course.

Week	Strategy	No. of students in Groups/individual assignment	Note
Weekly	Chapter reading and worksheet writing (including summary writing, and open-ended question answers)	Individual assignment	
Week 2-4	Lecturing, task completion	4-5 persons/group & Individual assignment	Group composed of course mates with whom they are more familiar
Week 5-8	Lecturing, task completion Workplace problems discussion (Experience sharing)	2-3 persons/group 4-5 persons/group	Group composed of course mates with whom they are not familiar
Week 9	Focus group discussion (sharing the most updated ideas/issues in the workplace)	10-12 persons/group	Group composed of those with similar backgrounds/working experiences
Week 10-12	Lecturing (on how to do problem solving reports) Group discussion on the problems to be presented in their final reports	4-5 persons/group	Group membership fixed for remainder of course. Lecturers help nail down the problem by asking students to give clear 'problem statements'.
Week 13-15	In class discussion on step-by-step problem solving solutions Group final report presentation preparation	4-5 persons/group	Group membership fixed. Lecturers help pin down possible solutions for each group's problem.
Week 16-18	Final report presentation Problem-solutions for the workplace handbook completion	4-5 persons/group	Group membership fixed. Students built individual portfolio derived from the learning outcomes of the course.

Table 1. Scaffolding strategies in the different stages of the course

REFLECTION: LEARNING EFFECTIVENESS OF PBL

Past research has shown the effectiveness of PBL, though much of this body of research has been restricted to advanced or relatively mature learners (Pederson & Liu, 2002). The research of Haruehansawasin and Kiattikomol, however, indicates that 'low-achieving learners in a PBL environment may benefit from more explicit guidance and encouragement to take a more participatory role in learning' (Haruehansawasin& Kiattikomol, 2018, p.369). This case study provides similar results and points out a key role played by scaffolding strategies in PBL learning, especially for low achievers or PBL novices.

Throughout the duration of the 4.5 months of learning, students were taught by means of well-designed learning activities and tasks that required the utilisation of dialogue, discussion and team leading skills by individual students, most of whom came with basic know-how in these processes. These in-class activities and tasks were an apparent factor affecting PBL novices' learning and their understanding of their roles in learning. Also,

textbook reading and weekly assignments were the foundation of problem-solving simulations. With a combination of lectures and facilitated in-class discussions, students did not get 'lost' or find it 'too difficult' during the process of learning and problem solving. Note that problem selection for each group's final presentation was based on students' own working experiences but specifically targeted at helping students solve a current job-related issue, which motivated students to seek out (better) solutions.

Learners' reflections on the course

As they were all novices to PBL, students found their first few weeks of learning 'puzzling'. Nevertheless, with the gradual adoption of soft scaffolding strategies in class, students got better acquainted with course mates and acquired increasing understanding of course learning goals. They also had to construct their own learning as learners placed in a 'student-centred' learning environment. Below is an excerpt from student comments during an in-class discussion on week 14:

> *'I now totally understand why the teacher had asked us to do the weekly assignment. I must be honest, I did not really like this weekly assignment in the beginning of the term. Now I must say this assignment is necessary! The weekly reading and writing tasks are to assist our understanding of the course theme and help us find better solutions to solve problems which we have encountered at work or in life.'*

The comment reveals how she came to link herself with the course's tasks and assignments, which were part of the scaffolding strategies used in class. She also understood (at last) that PBL was to help improve her soft skills in career development.

Facilitator's reflections on the course

Since past research has focused more on PBL being adopted for advanced learners, it might be a challenge for lecturers to adopt PBL for use with vocational students who usually do not perform so well in academic environments. In this case study, the successful PBL implementation, according to the facilitator's feedback, was attributed not only to the adoption of scaffolding strategies but also to the fact that these vocational students were all adult learners who came better equipped with group learning skills, especially those of dialogue and discussion based on their years of accumulated working experiences. This indicates that student-centred learning approaches, e.g. PBL, are less of a challenge for teachers to implement in such learning groups.

CONCLUSION

If one of the teaching goals in the 21st century is to teach students 'how to learn, un-learn and re-learn', PBL is one of the approaches to facilitate student acquisition of skills that will help them meet the challenges of rapidly changing needs in job markets (Tik, 2014).

The case presented herewith showcases how PBL can be implemented with scaffolding strategies for a group of vocational adult PBL-novice learners.

This PBL course was a one-off case. Surely, larger scale studies under a variety of settings and circumstances should be carried out in Taiwan if more funding can be located. Also, levels of soft skills acquisition in a PBL course can be further addressed through qualitative or quantitative analysis to verify the findings of this case study.

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Project-based Learning for Teaching Transmedia Communication

Maximiliano Bron and Manuel Gértrudix Barrio *

ABSTRACT

This case narrates the experience and shows the results of research study conducted at the National University of La Rioja (Argentina) where Project-Based Learning (PBL) strategies were implemented for the making of a transmedia documentary which was central to the students training in a particular class, which is part of the last year of the Social Communication Programme.

KEYWORDS: PBL; Transmedia Communication; Projects; Digital Communication

DESCRIPTION OF THE CONTEXT

The National University of La Rioja (UNLaR) is one of the 55 national universities in Argentina. The university headquarters are located in the capital city of the province but it also owns smaller offices all around the province.

This National University was created in 1972 as a provincial university and eventually turned into a national university in December 1993. It has approximately 25,000 students.

Multimedia Communication Course in Social Communication

In 2009 a new curriculum was enforced in the Social Communication Programme at the UNLaR, these modifications were made in order to face the emergence of new formats in communication such as digital communication. This was something new and no other universities had included it in their study programmes until then.

* Maximiliano Bron, National University of La Rioja, La Rioja, Argentina
Email: maxibron@unc.edu.ar
Manuel Gértrudix Barrio, Rey Juan Carlos University, Madrid, Spain
Email: manuel.gertrudix@urjc.es

With this new curriculum, in the year 2012 the Multimedia Communication course was established. Taking into consideration the new institutional profile, the establishment of this course implied the development of multimedia communication skills in students taking the fourth and last year of the Social Communication Programme (in both specializations: Journalism and Institutional Communication and Advertising).

Just as Mora (2004; 20) states, "the new demands in the system of higher education are not only related to knowledge itself but they also relate to the training of individuals in a more complex whole of competences that includes knowledge and the skills and attitudes that a job position requires". This is why "learning to learn" was key in the teaching – learning process of digital communication since knowledge in this area is constantly changing and information is rapidly outdated. In this sense, a life-long learning process is a must for the new professionals in the Communication field.

From the very beginning, the course of Digital Communication met two huge challenges: which contents to include and how to teach them. In this sense, having considered the fact that methodologies at universality level are not usually updated and adapted to this new and complex scenario of young students constantly stimulated by technological devices, some changes in methodology were proposed.

THEORETICAL AND PEDAGOGICAL FRAMEWORK

In order to face this local, regional and institutional reality "Project-based Learning offers the opportunity to implement student-centered approaches" (Maldonado, 2008, p. 172). These professional practices in class, help students to have a better understanding of the context and therefore, they can be inserted more easily in the labor market.

In this sense, Aguaded (2011, p. 15) states that: "the processes and results in the teaching-learning process have undergone significant changes because of the introduction of new technologies and media". The use of these new technologies and resources, responds to an emergent need on students, so they can be give professional answers and solutions, in changing and complex times.

Nowadays, we can find different meanings and modalities of the so-called Problem-Based Learning influenced by constructivism itself, particularly by approaches to information processing, situated cognition and sociocultural psychology. Among these new meanings and modalities, Project-Based Learning (PBL) stands out. This work was based on this approach.

As stated by Fernández et al. (2006, p. 400) "Project Based Learning is part of Problem-Based Learning", although there are similarities and also some differences, both are part of an approach on the rise which is being widely used at universities.

Using this method is mainly about an integrated approach based on activities that encourage reflection, also about complex thought, cooperation and decision-making.

IMPLEMENTATION AND CONCRETE ACTIONS

How are we supposed to teach the contents that are constantly changing? What should be taught about these contents? How are these contents supposed to be reduced and adapted within the huge field of digital communication? These were the questions that challenged our teaching practice and they were also the starting point for the design, planning and development of this university course that bases its method on PBL.

Teaching the contents that change year after year and considering digital communication as something that is not part of a traditional communication model was our proposal from the very beginning. That is how the new model of project-based work appeared naturally as well as this possibility for students to build their own knowledge and of being active participants of their own learning, among the methodological differences that started to be applied.

In this sense, Bron and Bazán (2015, p. 6) affirm that "experimentation in new forms of teaching becomes a necessity". It is now when the paradigm of the collaborative culture and the opening for the student to build their own knowledge and be an active participant of their own learning, becomes fundamental.

Transmedia as Part of the Strategy

The Project assigned during 2017 was released during the whole academic year and for all the group of students: "Project Victoria Romero". In this project, students had to make a transmedia documentary about the life of Victoria Romero, a local heroin. It should be considered that the relevance of the transmedia format as a project was the result of the characteristics of adaptation of the transmedia narrative itself to the pedagogical approach based on PBL, developed by the previously mentioned course.

> The concept of transmedia storytelling was first introduced by Henry Jenkins in an article published in Technology Review in 2002. In this article, Jenkins stated that "we have entered a new era of media convergence which makes the influx of contents through different channels inevitable." (Scolari, 2013:23)

Following Jenkins (2013), means of communication do what they know best, and thus "a story can be introduced in a film, expand on TV, novels or comics and this world can later on be explored in a videogame. Each franchise has to be independent enough to allow an independent consumption. That means, one does not have to watch the film in order to understand the videogame and viceversa" (Scolari, 2013:24). This is why, the idea that a story can be told through different media is highlighted, which allows the optimization and maximization of the characteristic of media and their particular possibilities.

Most certainly, transmedia storytelling is a very peculiar narrative that can be expanded through different systems of meaning (verbal, iconic, audiovisual, interactive, etc.) and different media (films, comics, TV, videogames, theatre, etc.). This is not about adaptation from one language to the other: the stories told in different media are not the same story, but they all contribute to the creation of a narrative world that comprises different media and different messages with an extended tale.

As it has been stated already, transmedia storytelling entails a common experience that comprises different media and devices, all of them tied by the same narrative thread.

Transmedia is trending, and, without doubt, as Carlos Scolari (2014: 173) affirms, "the concept of transmedia will be able to go out of fashion, just as it happened with multimedia, but the transmedia narrative logics are here to stay". Transmedia storytelling offers plenty of possibilities to generate strategies around a narrative world.

Considering this changing reality of format and narrative adapted to the new culture - a tendency that has been growing in the past years - and a number of possibilities that have moved recipients form their passive role, transmedia constitute a great possibility which also has its impact on education.

In this sense, "Project Victoria Romero", benefited from the transmedia project applied to the teaching and learning processes in which the multiplicity of formats and its immersive feature were key in its development. In this development, the three stages of teaching proposed by Jenkins (1991) take place (precreative, interactive and postactive), and contributes to the university study program in which "a wide variety of significant academic contents from the fields of highly specialized knowledge close to the world of work are concentrated" (Morandi & Ungaro, 2014, p. 99).

The proposal and the experience

The experimental aspect centered in pedagogical innovation has been a feature of the work in the class of Multimedia Communication. In this sense, *Project Victoria Romero* was an explorative program of development, research and educational innovation.

The object of this project was the creation, development, implementation and study of a transmedia story about local heroin Victoria Romero collectively told for educational purposes.

The project involves the creation of a non-fictional narrative world built by different elements and contents that gave the audience the possibility of having an active participation in the different media in which the stories were told. These tales were about the most representative heroes and heroines of the local history in connection to the fight for Federalism in Argentina (in 2016, similar projects were carried out about Facundo Quiroga and "Chacho" Peñaloza, another two local heroes).

By means of this project, the different educational uses of transmedia practices in the learning and teaching processes for the development of skills needed for digital communication and the active participation of students in their own professional training have been explored.

Because of the characteristics of this annual activity, the professors decided to base the project on the stories of significant local heroes and heroines. This was so, not only because it would motivate students more but also because it would involve the whole community that generally feels attracted by these types of local stories and personalities. Following Jenkins and his analysis of transmedia storytelling through the study of the activity of participant consumers and their contributions to the main story by creating content that expands the narrative world, the professors proposed an analysis of the transmedia storytelling from a pedagogical viewpoint was inquired in this project. This was based on the interest in new digital skills with the intention of analyzing the student's digital immersion and the cognitive, social and emotional consequences in the development of a transmedia story; the motivations of the recipients to tell the story of the personalities and their peculiarities were of particular interest.

Furthermore, the complexity of this project and its experimental and exploratory nature entailed a very important interdisciplinary work which allowed the building of a narrative world particularly designed for educational purposes.

The design of this project included three main objectives:

- Designing a narrative storytelling including activities that may provide the opportunity to get to know these historical figures.
- Analyzing the pedagogical benefits of the use of transmedia storytelling in students from high school level and primary level (only students in the last years).
- Describing the impacts of the use of narrative storytelling in the digital immersion of students and its cognitive, social and emotional implications.

The development of this project was modified by the introduction of different contents, which resulted in different experiences and results.

Victoria Romero as content and objective of PBL

In the year 2016, a PBL project named "Caudillos Riojanos" (heroes from La Rioja) was carried out (available at www.proyectocaudillos.com).

In 2017, it was decided to continue with the telling of the stories of local heroes and the focus was put on a local heroin this time: Victoria Romero. Victoria, "Doña Vito", Romero was a neglected personality in Argentinian history and a particularly crucial heroin for Federalism and our formation as a country" (Bron, 2017, p. 12). The transmedia project about her can be found at www.victoriaromero.com.ar.

The project Victoria Romero was centered in the recovery of the historical memory of "Doña Vito", the wife of Ángel "Chacho" Peñaloza (another local hero) as a heroin of Argentinian Federalism. As stated in the book that is part of the result of this transmedia work, the project pursue "to go back to the story of Victoria, to bring her back to life in Argentinian society, and to show how certain figures have been neglected in the official Argentinian history" (Bron, 2017, p.12). All of it with the goal of students reached new personal, emotional and professional skills working together, discussing and obtaining mutual feedback further the school and the classroom.

The parts of the product

In order to comply with the transmedia characteristics of the project, different contents were addressed. This can be found in full form in the website www.victoriaromero.com. This also represents the starting point (one of the possible ones) of the universe that contributes to the transmedia storytelling.

During the teaching process, the slogans and objectives to be met were delivered to the students. Afterwards, the students inquired about the story and narrative possibilities, taking into account the different techniques and possibilities of digital and transmedia communication.

As the Northwest Regional Educational Laboratory (2002) argues, "it is very important that all stakeholders or stakeholders have clarity about the objectives, so that the project is planned and completed effectively."

In this project, carried out during a full academic year, the teaching team has explained and detailed (at the beginning of the course) all the essential elements and expectations regarding the project.

Initial situation (first month of work):

- Situation or problem: The problem that the project sought to address or solve was described. In this case, it was to make Victoria Romero's life known in an innovative and creative way.
- Description and purpose of the project: The goal of the project was explained and how it addresses this situation: Making the citizenship of La Rioja (particularly children and youth) become actively involved in the recovery of Victoria's historical memory, as the main focus of the narration.
- Performance specifications: A list of historical, aesthetic and communication criteria were assigned, in the form of quality standards that the project had to meet.
- Rules: Guides or instructions to develop the project. Budgeted times (8 months) and different short-term goals were included, such as: content calendars, documentary presentation, school activities, etc.
- List of participants in the project and assigned roles: A basic general team design with predetermined roles such as leader, editor, informant, etc. was included. Next, the working group defined subgroups based on their own needs detected by the students. For example, audiovisual production group, advertising, social media, etc.
- Evaluation: It was explained how the assessment of student performance would be carried out through different instruments: evaluation of the teaching team, self-evaluation of the student and evaluation by peers.

Reviewing the different recommendations for the implementation of an activity based on Collaborative Projects Learning, we worked with the suggestions made by Dr. Lourdes Galeana (2006) from the University of Colima in Mexico and adjusted the process as follows:

A) <u>Starting point:</u>

- The topic related to the narrative of the life story of Victoria Romero was defined. We worked on facilitating a discussion of the topic with the whole class.
- Programs, partial goals and evaluation methods were established.
- Resources were identified. By working within a public university in the interior region of Argentina with insufficient resources, self-financing alternatives were established.
- The objectives of the project are established to fulfill the central objective that consisted in making known the life of Victoria Romero through a transmedia narrative.
- The teams were formed, establishing a frequency of mandatory meetings twice a week (2 hours each), located in the same university class.

B) Initial activities of the teams

- Pre-production or preliminary planning was used to share knowledge on the class and suggest possible tasks for the team (there were students in charge of historical research and to share the information with the rest of the members).
- A tentative calendar was established as well as a list of possible contents and activities for the achievement of the objectives.
- An estimated work plan was developed where the students defined the deadlines, the division of the project into tasks and assigned responsibilities for the 18 team members.
- Feedback from the team of teachers. In each of the weekly meetings, the teachers gave partial feedback about the progress with positive and negative points.

C) Implementation of the project

- The work plan was divided into a sequence of tasks, each with its programming and goal.
- With the approval of the teachers, the teams continuously adjusted the definition of the project.
- Throughout the process, team members took part in collaborative learning and cooperative problem solving.
- A self-evaluation and a mutual evaluation were carried out among the members of the teams. Both the teachers and the students did their evaluation and gave feedback.
- The final result of the project was a product, which (following the transmedia logic) had different related parties.

D) Conclusion from the students' perspective

- In the final review stage, the project was completed and the product was polished, it contained an audiovisual documentary as a central axis, as well as a public presentation or the interaction of the characters on social networks.
- For the final evaluation, a constructive feedback session was held where the whole class participated with the teachers.
- As a closure, the students and the teams analyzed their products, presentations or partial activities and concluded with the closing of the teaching team.
- At all times, the discussion and general evaluation of the project were facilitated in class.
- During the 8 months that the project lasted, a record of notes and files was made that facilitated reflection and documentation about the project.

As a result of the work done by the students, among the produced contents the following stand out:

a) Webisodes: web episodes in capsule format where the character's story is told in chapters of less than 5 minutes.

b) Documentary: is the centerpiece of the work that integrates the narrative from a traditional documentary format
(available at https://www.youtube.com/watch?v=mIIFiasB6FA).
c) Draw my Life: animation motion picture using freehand technique, which allowed to reach the children's audience.
d) Whatsappepisodes: copies of the webisodes to be shared via WhatsApp, after readapting the format and reducing its duration (1 minute per chapter).
e) Quizzes in a "trivia" format.
f) Hip-hop style song.
g) Interventions in public spaces, means of communication and schools.
h) Website: www.victoriaromero.com.ar
i) Social media (Victoria Romero's profile, fan page of the project, Youtube, Flickr).
j) Book: The students were authors of this work narrating the different steps taken to carry out the project, its benefits and learnings (available at http://libro-e.click/wp-content/uploads/2018/07/09.- Victoria-Romero-El-Valor-Riojano.pdf).
k) Participation of the audience: channeled through social networks.

* The complete project can be seen at www.victoriaromero.com.ar

FINAL REFLECTIONS

As has been shown, during the whole process of the Victoria Romero project, a series of contents for different media have been developed and actions have been taken. These actions have permitted the contents to promote their peculiarities by their integration to a very complex transmedia project signaled by its educational purposes intended to different audiences.

Furthermore, the interaction of the users made it possible to show the interest on the story and to keep a record of the necessities of each of the audiences. Acquiring knowledge, concerns, motivations and interests on the part of the recipients, made it possible to adapt some contents to the ongoing project.

Most certainly, the objectives of the project have been fully accomplished because the main educational purpose with the students in the Social Communication Programme was fulfilled. They were the developers of the Project Victoria Romero along with the professors of Multimedia Communication and they have proven to execute the PBL modality efficiently and successfully.

Similarly, based on the experience of transmedia education with the final recipients of the product (primary level students and secondary level students in their first years), the project met its goals connected to an educational and cultural activity in the sense that it

contributed enormously to the identity of the culture of La Rioja in the everyday life of its people.

As regards the process of investigation and action, besides the educational research, records of the recipients have permitted to generate new developments for the project. What is more, some broadcasting strategies could be rectified and some media and messages could be reconsidered.

Among the main advantages identified by Coria (2011, p. 5) in relation to the use of projects in educational processes we find that:

After the full year dedicated to the Victoria Romero project, it has been encouraged that students can think and act in the design of a project. Elaborating a plan with defined strategies, to give a solution to a question and not only to fulfill curricular objectives.

In addition, emotional, intellectual and personal growth was stimulated through direct experiences with people and students located in different contexts related to experimentation in digital communication.

In the same way, students learned different techniques for solving problems and working collaboratively, as well as learning to evaluate the work of their peers, and to give constructive feedback to themselves and their peers.

Undoubtedly, the process of developing a project of these characteristics allowed and encouraged students to experiment and obtain learning through their own discoveries and mistakes, facing and overcoming difficult and unexpected challenges.

As a closure, we remember that researchers such as Jenkins (2006) and Scolari (2010) have suggested many times that it may be known where a storytelling begins but it may never be known where it ends. The Victoria Romero Project relies on this statement and moves forward so it does not stop. The narrative record which resulted from the research work, makes it possible to improve the results year after year and to rectify mistakes they may have been committed.

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