PROBLEM-BASED LEARNING IN THE DIGITAL AGE

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ABSTRACT

Problem-based and project-organized learning (PBL) was originally developed to facilitate collaboration between physically present students; however, due to digitalization, collaboration, dialogues, and other PBL activities should take place online as well. With a theoretical point of departure from Dewey and a methodological point of departure from netnography, this study focused on a blended learning module at Aalborg University, where teaching is based on PBL. A primary research question was investigated: "How can IT support collaborative learning among learner communities in a PBL Master's program at Aalborg University?" The ways teachers and groups of students could benefit from utilizing IT as a platform for learning were examined. Netnography was the chosen methodology, and the data consisted of the course materials, the reflections, and the dialogues available online. The study showed that including more students allows for more discussions and reflections than including fewer students given teachers describe the task thoroughly and support the online dialogue. In addition, online collaboration allows students to return to the dialogue and re-use it as a resource for their dissertations, teachers can benefit from the online reflections and discussions to improve the educational design of the course, and researchers can obtain rich data from online reflections and dialogues.

KEYWORDS

Problem-Based Learning, Online Learning, Collaborative Learning, Workplace Learning, Learner Communities, Netnography

1. INTRODUCTION

It is well-established that dialogue, reflection, and collaboration are important elements of student learning (Dewey, 1916; Hmelo-Silver, 2012; Kolmos, Fink, and Krogh, 2006; Lazonder and Harmsen, 2016), and many universities integrate these elements through PBL. The literature highlights several advantages of PBL, for example the ability to stimulate critical, reflective, and creative thinking (Blackburn, 2015). Moreover, it accentuates student centeredness (Abercrombie, Parkes, and McCarty, 2015), students' active participation (Tambouris et al., 2014), and authentic ways for students to collaborate and create knowledge. With its roots dating back to Dewey, (1910), Piaget (1974), and Lewin (1948), PBL has been practiced in Denmark since the 1970s (Kolmos et al., 2006). Thus, most of the literature on PBL focuses on the practice of learning in offline face-to-face settings. Researchers have only recently begun to examine the role of learning technologies in PBL and the use of PBL for virtual classrooms and online learning (Lajoie et al., 2014).

A literature review revealed that PBL faces new challenges in online settings. Some studies showed that project work is not as beneficial for online students as it is for students who meet regularly on campus because online students must motivate themselves and solve problems alone (Lauersen, 2006). Online learning is also criticized due to the social isolation of students and technical issues that can. In this study, learning activities in an online learning setting for a specific course were examined to answer the following question: "How can IT support collaborative learning among learner communities in a PBL Master's program at Aalborg University?"

This article focuses on Aalborg University, where the pedagogical foundation is PBL, which is referred to as the "Aalborg PBL model" (www.aau.dk). According to the Aalborg PBL model, the students find an issue that makes them wonder, and they formulate the speculation as a question. This is the starting point for learning. The curriculum of the course frames the problem definition and analysis, and the students work in supervised groups during the planning, management, and completion of the project that addresses the problem. Finally, the students defend the project report orally. Most often, this defence is evaluated by the teacher and an external examiner as a final grade for the course.

Technology can provide additional support mechanisms for real-time supervision that are not available when PBL is conducted in a face-to-face setting (Lajoie et al., 2014). In addition, Learning Management

Systems, such as Moodle, require new teaching practices (Ravitz and Blazevski, 2014). This paper discusses how PBL can utilize IT to enhance reflection, dialogue, and collaboration among students in the digital age, and an analysis of a learning design for PBL in an online setting is presented.

2. THEORETICAL FOUNDATION

This section presents the theoretical foundation, which includes Dewey's conclusions (1910) related to PBL, as well as a comparison between PBL in a face-to-face setting and in an online setting.

2.1 Dewey and PBL

According to Dewey (1910,), thinking begins with a dilemma or state of perplexity that demands a solution. The difficulty of the problem causes students to reflect, which involves considering the definition and the location of the problem and briefly developing potential solutions that require further inquiry and experimentation to accept or reject the premature solution (Dewey, 1910, p. 72). To think critically, students must be curious and should spend a sufficient amount of time inquiring about the nature of the problem and investigating the facts before they can "digest impressions and translate them into substantial ideas" (Dewey, 1910) for solutions. Inquiry initiates critical thinking, and this type of thinking occurs differently for different students (Dewey, 1910); hence, it may be beneficial for students to work in groups to reflect collaboratively, enhancing the inquiry process. The inquiry includes two movements: induction, or developing ideas, and deduction, or developing, applying, and testing ideas (Dewey, 1910). Inquiry includes data gathering, analysis, and synthesis, and these steps lead to the development of premature ideas that must be evaluated to become suggestions for solutions. The students' "own good (or bad) judgment is the guide" when they evaluate data to identify conflicts in the definition and location of the problem and to analyse facts (Dewey, 1910, p. 106). From problem identification to solution suggestions, the process includes different ways of thinking, beginning with the sense of difficulty caused by perplexity and continuing with reflection, which leads to the identification of the problems that require inquiry.

The outcome of educational thinking is twofold (Dewey, 1910). First, the student identifies the meaning of the problem and the location of the problem. Second, the student develops suggestions for solutions to the problem that initiated the thinking process. Although several learning theorists' findings inspired the PBL model (Kolmos et al., 2004), Dewey's findings were the foundation for the general views of learning, collaboration, and inquiry related to PBL.

Both in Dewey's writings (e.g., 1910, 1916) and in various framings of the models, phases, and steps of PBL (Tambouris et al., 2014), the teacher's role is not restricted to the supervision of students' collaborative thinking and project work. Learning involves more than individual reflection and creative processes. Dewey (1910) provided guidelines for teachers and suggested how teachers can best help students memorize and recite content, but he emphasized that the teacher's attention should be focused on instruction and supervision to support and enhance students' reflection and collaboration skills. In Dewey's writings, it is implicit that the teacher is in physical proximity with his or her students on a regular basis, as this was a common instruction practice at the time. He died in 1952, which was long before the invention of personal computers and the internet; however, while the issue of proximity is still a focus, proximity can be either physical or online.

2.2 PBL Activities Face-to-Face and Online

When PBL occurs in an on-campus setting, students usually prepare for class at home, whereas most interactions between the teacher and the students and between the students usually occur on campus. Hence, the activities of the students and the teacher are distributed to different times and spaces, and the teacher's access to the students' activities is thus limited by time and space. Activities "disconnected from the teacher" involve the students' preparation for class and group work, including problem formulation and writing project-reports. The activities within "physical proximity with the teacher" include lectures, in-class discussions, supervision, and the final exam. The teacher is usually only involved on campus, so the teacher only has access to students' reflections, collaboration, and progress when discussed during supervision

sessions. The lack of physical proximity limits supervision, instruction, and learning activities for traditional PBL; hence, efforts should be made to improve proximity between students and teachers.

In online settings, PBL allows for participating in collaborative activities across time and space. Students do not need to find an available room for collaboration or supervision; they only have to agree on a time for the synchronous activities (Nortvig, 2015). In addition, they only require a common space online in which to contribute asynchronously to the dialogues at a time that is convenient for them. Thus, all student activities can occur within proximity of the teacher because the teacher is reachable online. The students can engage in lectures, dialogues, supervision, collaboration, and other activities from any location, as they do so online.

3. METHODOLOGICAL CONSIDERATIONS

This section explains the methodology and methods utilized to investigate the role of PBL in the digital age in a specific research setting.

3.1 Netnography

To analyse an online PBL learning design, netnography is appropriate because it is a methodology used for online field work in which IT represents the main resource for data collection (Kozinets, 2012, p. 102). Netnography allows researchers to investigate activities in online learning settings without physical presence, which means that researchers can be present in these settings at any time from any location and can investigate learning activities and course material years after the courses end.

Research on online data is intangible, and most data are text-based, although they may include sounds and pictures as well (Hughes, 2012). When the data lack sound and pictures, researchers cannot analyse body language cues, such as gestures, tone of voice, or clothing (Kozinets, 2015). The distance between the persons under study and the researcher often eliminates social cues, such as age, gender, and ethnicity, and the distance also reduces the researcher's impact on the participants because they cannot see or hear the researcher (Kozinets, 2015). In this study, the researcher investigated online learning activities, but she was not able to analyse body language cues. However, the researcher knew the students from teaching the course and from supervising the students online. The exploration of the course design took place two years after the course ended. In this way, research distance was developed.

3.2 Research Setting and Data Collection

The data were gathered from the Master in ICT and Learning program (MIL) at Aalborg University, specifically from a course entitled "Proactive Review: An Educational Design for Organizational Learning." The course was offered in 2013 and 2015 and was valued at five ECTS, with a student workload of 137½ hours. The requirements for attending MIL are a professional bachelor degree such as teacher or nurse, or alternatively ad BA in humanity or social science, or alternatively a MA, as well as relevant work experience for at least two years and good skills in IT and English language. In both years half of the students held a Master's Degree and the other half held a professional bachelor degree. The first lecture took place face-to-face, and the remainder of the course consisted of online activities only. The educational design of the course stayed the same over the two years except for the choice of tools for online collaboration being Google Group in 2013 and Moodle Forum in 2015. The difference in the choice of technology is a matter of availability. The students suggested Google Groups as the common IT platform, as Aalborg University did not provide a learning management system with collaboration tools in2013. This changed in 2015, and Moodle was an easy choice.

The data were collected from Moodle and included the teacher's lesson plans, lists of literature, slides from the initial face-to-face lecture, exercises, and students' written conversations and online reflections in 2015; the conversations and reflections in Google groups in 2013; and the slides from the videoconference in 2013 and 2015.

MIL students worked as professionals at private or public organizations and study part-time, and they were located all over Denmark and Norway. As they were geographically dispersed, it was important for them to study and collaborate online. Proactive review is an educational design for organisational learning

consisting of seven open questions asked in a specific sequence. The proactive review course presented this educational design and enabled the students to try it out in roleplays, before they experimented with proactive reviews in their work places, which was followed by reflections. It should be noted that many elements of the course are not described in this article because the focus is the learning activities, and the online tools utilized are mentioned but not described in detail. The teacher prepared for the course by selecting relevant texts. For the in-class lecture she prepared oral presentations, in-class group work, and role-playing activities, and she prepared the online spaces for online presentations, reflections, inquiries, and analyses. Students prepared for the introduction by reading the texts. The flow of the proactive review course is shown in Table 1.

Table 1. Activities and technologies of the online PBL proactive review course

Time	4 hours	6 weeks	3 weeks	2 hours	2 weeks	1 week
	Week 1	Week 2-7	Week 8-10	Week 10	Week 11-12	Week 13
Teacher activities	Present theory Conduct experimentation with proactive reviews Supervise reflections on experimentation	Students experiment with proactive review at their workplaces	Supervise online reflections and inquiries of different theories of organizational learning	Supervise collaborative reflections on difficulties and relevant theories Supervise problem identification	Supervise collaborative analyses and idea-generation and reflection	Read reports Examine/ evaluate
Setting	Face-to-face	Field	Discussion forum (Moodle/ Google Group)	Video conference (Adobe Connect)	Moodle/ Google Groups	Folder file on Moodle
Student activities	Become curious about the topic Experiment with role play Form groups Groups decide location for experimenting with proactive review	Experiment Identify a difficulty in running a proactive review	Individual and collaborative reflection on the identified difficulties Inquire by including data collection for theories Formulate a problem based on the difficulty	Present the problem	Analyse the problem Develop ideas for solutions Reflect collaboratively and test the ideas	Write the report, including the location of the problem Suggest solutions

The proactive review course began with a face-to-face introduction in which students were introduced to theories related to organizational learning and proactive review as an educational design for organizational learning (Kolbaek, 2014). The teacher's aim was to stimulate students' curiosity about learning in the context of work, specifically the educational design for collaborative learning. During the introduction, the teacher briefly presented relevant theories and the format for the proactive review. She initiated experimentation with proactive reviews during role playing activities, and she supervised students' reflections on role play by

asking them to provide specific feedback. The students formed small groups that served as learner communities to discuss the theories and to choose a specific theory as their focus. The role-playing activities enabled the students to experiment with proactive reviews at their workplaces. They chose a location to try out at least one proactive review, and then they prepared for their proactive review. The outcome of the introduction was a common understanding of a proactive review and a plan for subsequent work.

For the first six weeks after the introduction, the students were occupied with other courses required for the master program. During this period, the learner communities prepared and implemented at least one proactive review at the workplace. Then, they formulated a difficulty they experienced during their experiments. The teachers did not interfere in the group work or in the experimentation with proactive reviews. The learner communities chose the online space for collaboration on their own without interference from the teacher. The student outcomes of the experimentation period were acquiring experience with an educational design for organizational learning at the workplace and developing curiosity regarding a difficulty they faced.

For the following three weeks, some learner communities used Google Group, and others used private Facebook groups, FaceTime, Skype, emails, etc. Using the common Moodle forums (2015) or Google Group (2013), the teacher supervised the students' collaborative reflections and inquiries of different theories of organizational learning. The learner communities reflected on a specific difficulty and inquired about the issue through the lens of a theory they chose, which the group presented in an online discussion forum. This was followed by individual comments on at least two theories presented by other groups and by individual replies to at least two of the comments from fellow students. The outcome of the three weeks of reflection and inquiry was thus the identification of problems. By the end of the three weeks, the learner communities had formulated problems based on a difficulty they experienced, and each group presented their problems to fellow students and to the teacher during a two-hour video conference using Adobe Connect. In 2015, 17 students presented seven problems: "who is to participate," "do the participants need to have shared a task," "which contexts are suitable for proactive reviews," "which competences are required for supervising proactive reviews," "how to introduce proactive reviews in an organization," "how to ensure commitment to the agreements in a proactive review," and "how does the supervisor capture all the good ideas generated during a proactive review." In 2013, 12 students presented three themes for discussion: "power distance," "prerequisites for the participants," and "preparation for a proactive review."

Over the following two weeks, students analysed the problems by gathering examples (data) from fellow students' experiences that enabled them to generate ideas for solutions. Students then reflected collaboratively to test their ideas. The teacher supervised the online collaborative analysis, idea generation, and reflection and ensured that all students actively contributed. If the dialogues waned, the teacher commented or asked questions to initiate reactions. If the dialogues lost focus, the teacher led students back to the topic. During the 2015 course when a Moodle discussion forum dialogue wavered, the teacher intervened 14 times—an average of twice per dialogue (the dialogues included 93 contributions and an average of 4.6 contributions per student, and the students contributed equally). In 2013, the dialogue took place using Google Group, and the teacher intervened 21 times—an average of seven times per dialogue (the dialogues included 75 contributions and an average of 4.5 contributions per student, and the students contributed equally). The outcome of these two weeks of thinking and collaboration was the creation of tentative solutions to the problems identified. The online space had no effect on the activity of the groups or the need for teacher intervention.

The exam at the end of the course consisted of a group or individual student report, including the location of the problem based on the theories, suggestions for solutions, and reflections on the learning process during the course. Students uploaded their final reports in Moodle, and all the students passed the exam.

4. ANALYSIS

This analysis involves examining activities that support learning, such as curiosity, problem location, experimentation, identification of difficulties, reflection, problem identification, inquiry, analysis, and suggestions for solutions. In addition, the use of the different technologies utilized in the blended learning course is analysed (Dewey's 1910, 1916).

The students collaborated in a digital space, and when they wrote their reflections in the digital space, they made the reflections accessible to teachers, fellow students, and researchers. Inspired by Dewey (1910), this study explored how the teacher initiated curiosity and experimentation as well as how she stimulated the students' identification of a difficulty to initiate reflection, make inquiries, and perform analyses to develop suggestions for solutions to the problems identified. The teacher created curiosity about learning in the context of work by presenting theories and by enabling students to experiment with proactive reviews during role-playing activities. The students' curiosity, along with the teacher's requirements for the course, allowed the students to plan for further experimentation. The teacher emphasized that there must be a problem location, and the students chose a workplace as their specific problem location. For this course, the data showed that online collaboration did occur without a need for teacher supervision. Thus, the teacher did not support or interfere with the students' experimentation with proactive reviews, but she asked the students to discuss the difficulties they encountered during experimentation. The teacher provided the students with the confidence to share their difficulties, and these difficulties became the basis for reflection and inquiry.

The teacher supported reflection online in different ways. First, by asking students to choose a theory as their focus, the teacher motivated them to reflect on the theories they found most relevant or interesting. Second, by asking students to decide which workplace would be most suitable for experimenting with a proactive review, the teacher induced the students to discuss their individual workplaces and to reflect on the pros and cons of each before making their choice. Third, by asking the students to identify a problem to present during the video conference followed by an online dialogue, the teacher prompted the students to reflect on their experiences of implementing the proactive reviews. Fourth, by asking the students to reply to the questions raised in the online dialogue and by asking them to involve the theories in their replies, the teacher motivated the students to reflect on the theories in connection to the problems they or their fellow students experienced during their proactive reviews. All these questions were uploaded to Google Group the first year and to the Moodle front page the second year. Using this forum as a meeting point for the course, the teacher was able to reify and maintain the goals for the course. Thus, in the forum, she linked the face-to-face meeting (and the activities taking place there) with the independent off-campus experimental phase. Moreover, the Google Group/Moodle front page was used as a link between the problem identification during the video conference session and the following online asynchronous period as well as between the course material (theories) and the students' experiments and problem identification.

To identify a problem, the teacher asked the groups to move from difficulties in a specific case (namely, the proactive review they experienced) to the more general problems of a proactive review and to write and share their thoughts in the Google Group/Moodle Forum. In 2013, students identified three problems, which they formulated as headlines for their inquiries; in 2015, students identified seven problems, which the teacher asked to be formulated as questions. When the students formulated the problem, they were able to share their thoughts to a higher extent with less support from the teacher. When teaching using a video conference, it is recommended that the lesson be well-structured and planned so that all students feel engaged and are eager to participate and collaborate (Gill and Richardson, 2005). Online synchronous dialogue is important to supporting the trust that develops "when people have enough information about others to understand them and accurately predict their behaviour" (Thompson, 2015, p. 126; cited in Callister and Love, 2016, p. 247). During the course under investigation, the video conference session continued the online dialogue, and it also created a foundation for further collaboration. The video conference also allowed the teacher and the students to exchange body language and other nonverbal cues, such as smiles, nodding, and eye contact, which supported trust-building. Furthermore, body language cues could be used to indicate which group or individual student most needed help from the teacher.

The teacher initiated the students' inquiry process when they were asked to investigate their various workplaces to determine which would be suitable for implementing a proactive review. The teacher asked the students to inquire about and analyse the problems by gathering data from their experiments and by searching for more information based on relevant theories. The inquiries were shared online in discussion forums in Moodle or Google Group, where students took their point of departure of the entire experience from the experiment and added more details by including more data and relevant theories. Furthermore, the teacher supported inquiries by asking students to participate in the dialogues, which probed their insights regarding different problems and different workplaces as contexts for proactive reviews. The teacher supported inquiries in physical settings (the workplaces) as well as online settings (Google Group in 2013 and Moodle in 2015).

The teacher supported the students' collaboration skills by requiring the preparation and supervision of the proactive review, during which all students participated. The teacher also supported the students' collaboration skills by asking them to share their reflections and inquiries online and to read and comment on fellow students' thoughts. The teacher sustained student collaboration by asking the learner communities to identify problems that occurred during the proactive reviews and to contribute to the online dialogue with comments and questions. Because all students could read what the teacher wrote to a single group, online supervision enabled the supervision of the entire group at the same time. Moreover, the supervision of each group was more focused because the evolution of the students' arguments was easily followed in the forum.

The teacher continuously reinforced the creation of solutions to the problems identified by the students by leading the students through the process of educational thinking. This process began with experimenting and was followed by experiencing difficulties. This led to reflections on the experiment and the identification of the problems that occurred during the proactive review, which were investigated and analysed before tentative solutions were presented and discussed by fellow students. The teacher required suggestions for solutions in the final report, which included the location of the problem as well as the students' reflections regarding the learning processes. The reports served as important feedback for the teacher because they provided valuable insights into the students' learning processes and outcomes related to the course.

5. DISCUSSION AND CONCLUSION

In this study, the question "how can IT support collaborative learning among learner communities using PBL for a Master's program at Aalborg University" was explored. The IT utilized consisted of Google Group, Moodle, and video conferences from which the data were collected. Hence, this study could be classified as a netnographic study (Kozinets, 2012). Most of the data were text-based and lacked body language cues, such as gestures or tone of voice, but the researcher knew the gender, age, and ethnicity of the students because she had met them face-to-face during the introductory seminar. To establish and maintain trust and confidentiality (Hughes, 2012), the discussion forums of Google Group and Moodle were only accessible to the teacher and the students. When the teacher wanted to utilize the data for research, she asked the students for consent, which they willingly provided.

This study shows that the online students did not struggle to motivate themselves, although the students in 2013 needed more teacher support than the students in 2015. The teacher contributed 21 times to three different problem threads in 2013, whereas she contributed only 14 times to the seven problem threads in 2015. The reason could not be differences in student-competences, as approximately half of the students held a professional bachelor degree, and half of the students held a Masters' degree and several years of experience in IT as the basis to attend the MIL programme. So another reason for the reduced need for teacher support could be the number of students. It appears to have been easier for 17 students to maintain the pace online than it was for 12 students. Thus, the extended number of students may have led to livelier interactions online. The framing of the problem could also have contributed to this outcome. It appears that problems formulated as questions enable students to discuss the problems to a higher extent than if the problem is formulated as a headline. Technical problems do not seem to cause difficulties. When the teacher asked the students to find an online space for collaboration, they did so without assistance. The discussion forum can easily become silent and inactive without supervision because students may feel isolated. This study showed that inactivity and isolation can be resolved if the teacher requires a certain amount of activity, such as two comments and two replies to comments.

In contrast to so-called traditional teaching in face-to-face settings, this approach to teaching PBL online has several advantages: reflection as an activity is reified in the online space, and as such, the activity is not only a process but also an object that can be re-consulted and meta-reflected at a later time. The students can benefit from these written dialogues and reflections by returning to them when appropriate, such as when writing a thesis.

Moreover, due to the digital traces of activity, the teacher can easily track and take action with students who do not follow the course plan. Therefore, supervision can be targeted toward individual students, and collaboration in groups can be supported individually as well. The teacher can add to or change the program to enable as many students as possible to pass the exam. Because all students passed the exam, the teacher's support does not need to occur in a face-to-face or in a synchronous setting; a timely online presence seems

to be more efficient for maintaining inquiry, dialogue, collaboration, and reflection. IT supported collaborative learning among learner communities using PBL for a Master's program at Aalborg University by creating proximity between students and the teacher, between students in the learner communities, and between the learner communities.

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