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INTRODUCTION

Welcome to the second issue of the ninth volume of the Journal of Problem Based Learning in Higher Education. This is our regular annual issue and contains six research papers and two case studies of PBL in practice. We have a total of 23 authors presenting, from across the world, and once again we have several different disciplines represented in the papers and the research studies. Here should be something for everyone.

The papers in this issue deals with multiple subjects. Group work and group dynamics, figuring out the group process, is in focus for one article, while another identifies motivational types amongst students in a PBL environment. We have two articles that look at the challenges of implementing PBL pedagogies, one with a focus on faculty, and the other on undergraduate students. The digitalization of education is also represented in a piece looking at the consequences of applying the technic of flipped classrooms. Finally, we have an article presenting theories from culture learning and mediation as part of a PBL based setup for teaching psychologist students finding the way into their future profession.

The two case studies of PBL also deals with multiple subjects. One in engineering focusing on integrating engineering with other disciplines such as arts, humanities, and business. The other describe a distance learning course for teachers focused on PBL the application of neuroscience concepts.

2021 has also been a year with Covid-19, but things are slowly finding a new normal. In August, Aalborg University in collaboration with the PAN-PBL organization hosted an international conference with the title theme “Transforming PBL through hybrid learning models”. It was a great occasion to revisit, or visit for the first time, the great family of PBL researchers around the globe (in digital form), and listen to the latest ideas, findings,

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and strategies. Some of the presenters are finding their way to our journal, and hopefully we can continue to grow in viability, influence, and acknowledgement.

Problem based learning is in high demand as politicians and decisionmakers look to higher education for solving the complex and high stakes problems of today. It is also increasingly popular amongst the students, who in a growing number are first generation academics, motivated not only by traditional knowledge acquisition, but by knowledge integrated in multi-perspective contexts of application, progress, and development. Students and stakeholders seem to recognize the value of PBL. However, we as researchers, need to keep investigating the reasons and the core of PBL, keep developing the tools, technics, and facilities of PBL, and of course challenge and support the epistemic value of learning through PBL in higher education. To this, our journal is dedicated, and we look forward to continuing to publish high quality research as part of the international PBL community.

As editor-in-chief and editor of case studies, we would like to thank our long-term members of the editorial team Jette Egelund Holgaard and Jakob Davidsen for their outstanding work and relentless effort to develop the journal and ensure the high standards that we strive for. Both Jette and Jakob will be missed, as they by January 1st, 2022, no longer will be part of the team.

THANKS TO REVIEWERS

Finally, we would also like to thank all the reviewers who have donated their time and wisdom to help to improve the papers and cases in this issue:

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Group Processing: Students Reflections on the Experience and Impact of Group Processing

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ABSTRACT

Problem-based or Enquiry-based learning is recognized as a transformative pedagogy, but there is a paucity of research examining group processing, a critical component of this pedagogy. Group processing is a structured approach to peer- and self-assessment that encourages learning that is both self-reflective and collaborative. Students develop the skills of peer and self-assessment, they learn to receive and deliver constructive feedback, and they benefit from continuous assessment. This article presents a mixed method study that asked former students, who had taken an enquiry-based learning seminar within the past 10 years, to reflect on their experience of group processing. Participants concluded that, based on their own experience, group processing is a skill transferable to other contexts and had a significant effect on their university experience.

Keywords: Problem-based learning, enquiry-based learning, group processing, peer review, student experience

INTRODUCTION

For almost twenty years, various proponents of collaborative learning and problem-based learning have advocated the use of group processing as an integral aspect of both student learning and student assessment (Johnson & Johnson, 1999; Johnson, Johnson & Smith, 1998: Johnson, Johnson, Stanne & Garabaldi 1990). Group processing is a crucial element of cooperative learning (e.g., problem-based learning) that stimulates student engagement. During group processing, students evaluate the effectiveness of the learning process by (1) describing helpful and unhelpful strategies among group members, (2)

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deciding which behaviors require change, and (3) acknowledging group members' success (Johnson & Johnson, 2018). Group processing is intended to create a safe space for group members to provide continuous, constructive feedback to each other in order to build a sense of community and encourage realistic evaluations of individual strengths and weaknesses relevant for group learning (Murray & Summerlee, 2007). Thus, group processing can be more than a simple strategy to manage a collaborative classroom or assess students.

There are multiple manifestations of collective or collaborative learning in post-secondary education. These can range from ill-defined "group work" to various team-driven assignments and projects, to a wide variety of activities that organize how students approach problem-solving. Collaborative learning, more than a set of techniques, is a social constructivist philosophical orientation that considers learning as the emergent quality of organic interactions between members of a learning community. It focuses on the role that social relationships play in creating community-specific learning processes and meaning out of reflective enquiry (Johnson & Johnson, 2018; Oxford, 1997). Relatedly, cooperative learning is the technique-oriented foundation of multiple active learning pedagogies that centers interaction within small groups as the main catalyst for learning (Johnson & Johnson, 2018). Cooperative learning strategies foster the development of cognitive and social skills via principles of positive interdependence between group members and accountability for others' learning (Oxford, 1997). Group processing is a core element of cooperative learning techniques (e.g., problem-based learning) aimed at identifying and implementing ways to improve the group learning process (Johnson & Johnson, 2018).

One of the more structured pedagogies to incorporate group processing is closed-loop reiterative problem-based learning (Barrows, 1986). To avoid confusion with other pedagogies that are centered on problem analysis or problem solving, the term closed-loop, reiterative, enquiry-based learning (EBL) has evolved to distinguish this mode of learning from courses that use problems in their teaching, lectures or group assignments. In contrast, enquiry-based learning adheres faithfully to the structure and components of Barrows' closed loop reiterative problem-based learning (Summerlee & Murray, 2010). For this pedagogy, closed-loop refers to the process by which students first identify learning issues that emerge from the "problem" and then engage in researching those issues. The loop is closed when the students bring back their individual research findings and integrate them with the problem and each other's research. Reiterative alludes to the fact that the initial research might not fully address all the learning issues or, indeed, might raise others that require research. Thus, the process begins again and can be reiterated until the case is satisfactorily explored (see Figure 1 in Murray, Giesbrecht, Mosonyi, 2013). In terms of the present study, Barrows' (1986) original pedagogy for

medical education was implemented in small, interdisciplinary first-year seminars, which are described in greater detail below.

There is a broad and deep literature that assesses problem-based or enquiry-based learning from the perspective of learning experience and outcomes (Hmelo-Silver, 2004; Murray & Lachowsky, 2017; Murray & Summerlee, 2007; Summerlee & Murray, 2010). In one important study, researchers found that group processing enhanced both individual achievement and group productivity (Johnson et al., 1990). Another study compared individualistic learning, collaborative learning without group processing, and collaborative learning with group processing. The results showed that the group processing students exceeded the other groups in terms of problem-solving success and achievement. Perhaps more significantly, the study found that students of all abilities and levels of academic achievement benefited from group processing (Yager et al., 1986). Another study examined the impact of four different types of problem-based learning according to how group processing was implemented. These were cooperative learning without group processing, cooperative learning with teacher-led group processing, cooperative learning with teacher-and student-led group processing, and individual learning (Johnson et al., 2000). The results reveal considerable variation across the groups using different modes of group processing. The researchers concluded that the teacher-and-student-led group processing had the most significant impact on student learning. Thus, learning strategies that include group processing, when compared with other approaches, may contribute most to enhance student learning. There are, however, few studies about group processing and its efficacy, and what little research has been done is now dated (Johnson, 1990; Yager et al.,1986).

More recent research demonstrates that peer feedback in problem-based learning has both advantages and drawbacks. On one hand, students reported that peer feedback helped them identify and reflect upon their own strengths and weaknesses, which subsequently improved their performance (Dannefer & Prayson, 2013; Geitz, Joosten-Ten Brinke, & Kirschner, 2016; Papinczak, Young, & Groves, 2007). Similarly, peer feedback improved the quality of contributions among low-engagement students and positively influenced both individual and group functioning (Kamp, Dolmans, Van Berkel, & Schmidt, 2013). Further, following peer feedback, students reported an increased sense of responsibility for the learning of others (Papinczak et al., 2007), increased engagement, team-building and analytical skills (Kritikos, Woulfe, Sukkar, & Saini, 2011), and higher levels of competence in communicating feedback (Geitz et al., 2016). However, students' perceptions of peer feedback also demonstrated several of its limitations. For example, students explained that peer feedback was not always taken seriously (Kamp et al., 2013; Papinczak et al., 2007) and questioned its fairness as an assessment process given that peers lacked confidence in peer evaluation (Kritikos et al., 2011; Papinczak et al., 2007). Moreover, students considered that peer feedback could be biased and dishonest

(Papinczak et al., 2007; Rodgers et al., 2015). In some cases, students felt that peer feedback undermined harmonious group dynamics by promoting judgement and defensiveness (Kritikos et al., 2011; Papinczak et al., 2007). For these reasons, students reported an appreciation for peer feedback that was anonymous (Kamp et al., 2013; Papinczak et al., 2007).

This study examines students' perspectives of their experience and learning in courses using a rigorous and regular form of group processing. This study emerged from our own experiences as facilitators and observations of our students. As students incorporated this form of group processing into enquiry-based learning, we observed how they went through positive changes in skills, understanding and attitudes towards learning, irrespective of their chosen disciplines or course topics. In particular, students acquired skills in giving and receiving critical feedback. They moved from the superficial to the profound and became reflective of their learning attitudes and behaviors. Groups coalesced and developed healthy dynamics that supported the learning of all members. We believe this was the result of group processing but there was no supporting data. This paper seeks to fill that lacuna by reporting student perceptions of group processing; it examines how these perceptions changed over the length of a course, and if the skills developed through group processing were transferable to other contexts.

Group processing is fundamental to the enquiry-based learning pedagogy. In contrast to traditional assessment mechanisms that focus on learning outputs, group processing opens a new means of assessment that focuses on the learning process. Further, group processing assessment is not instructor-centered because it is shared and completed by all group members, faculty facilitator and students alike. It also addresses the weaknesses of peer assessment which lacks transparency if anonymous, or lacks accountability if there are no mechanisms for mutual responsibility. Group members develop mutual trust through transparent and accountable mutual feedback. Moreover, group processing supports groups and individuals to become high functioning and successful. Without the capacity to assess a group's process, that group may begin to falter, thereby weakening their ability to address learning issues (Jones, 2002). Group processing provides a valuable means to check-in with the students, individually and collectively, throughout a course.

According to Hmelo-Silver (2004), "reflection helps students (a) relate their new knowledge to their prior understanding, (b) mindfully abstract knowledge, and (c) understand how their learning and problem-solving strategies might be reapplied" (p. 247). Thus, through group processing, students come to understand themselves as learners, knowledge producers, and team members. This form of reflection allows them to think through their learning activities and re-access their focus and commitment (Moon, 2001). For example, when researching an issue, one student may not have found

sufficient information while another might have engaged in deeper research and found a wealth of information. In the context of group processing, students have the opportunity to receive feedback, reflect upon the differences in the quality of their research, and to set goals for improvement.

Group processing reinforces positive interdependence among students and also heightens individual accountability. During the feedback session, each person sees themself as related to every other member, as both a collective and an individual upon whom the group relies (Johnson & Johnson, 1999). Cooperation and academic improvement are enhanced as students help and encourage each other through constructive feedback and through the development of communication skills (Johnson, Johnson, & Smith, 1998).

Group processing is also a promising strategy to implement continuous feedback for students. Critical reflection provides a basis from which students can improve. It also provides a foundation for giving and receiving critical feedback in an open and transparent context (Johnson & Johnson, 1999). This allows students to learn how to receive feedback without defensiveness. Students can thus begin to recognize their strengths and areas for improvement, and use the reflective process to guide their growth as learners. Students receive individual feedback from all group members, including the faculty facilitator, after every single class meeting. This could amount to as many as twenty-four individual assessments in which students see their strengths and areas for improvement reflected back to them. This is a considerable increase in feedback compared to more conventional modes of feedback and assessment, given that numerical grades on examinations or brief comments on essays are not always self-evident to the student. Hence, the dynamic and continuous feedback inherent in group processing provides students with a body of assessment and feedback that motivates continuous improvement.

Context

Since 2004, the University of Guelph has offered the First-Year Seminar (FYS) program. This is not a formal academic program/credential, but instead a cross-campus initiative to provide autonomous and free-standing one-off seminar courses for first-year undergraduate students taught under a single rubric. That rubric requires seminars to be interdisciplinary and provide students with the opportunity to develop both higher-order thinking and transferable skills. There are approximately 35-45 seminars offered across the Fall and Winter semesters. Any first-year student is eligible to enroll in any seminar; there are no prerequisites and seminars are not affiliated with disciplines or degree programs. Rather, all seminars qualify as credit electives in diverse programs across the university. Faculty members submit proposals which are vetted by a committee to ensure they adhere to the program guidelines (Krometis, L.-A. H. et al., 2011; Kuh 2003; Lattuca,

Voigt & Fath, 2004; Lizzio & Wilson, 2004; Youatt & Wilcox, 2008; Stebleton, Jensen & Peter 2010).

There is no mandated pedagogy in the seminars, providing each uses a form of active learning and fosters critical thinking, research, and presentation skills. Making use of the small class size (usually 18 further divided into groups of 9-10 students) and pedagogical flexibility, a number of seminars have been offered by various instructors specifically using closed-loop reiterative enquiry-based learning (EBL). While these seminars were not connected formally or informally, they all adopted the same format. Seminar groups met twice a week for one and a half hours. The EBL seminars were focused around a series of cases that address complex, intriguing, or perplexing issues. The cases were presented as scenarios that provided sufficient context for students to identify the main issues and what they needed to research in order to move forward. In the first session for each case, students analyzed the scenario by writing down what they knew and did not know, and what issues they needed to research (i.e. "learning issues"). Each student selected a learning issue to research and returned to the group at the next session to present this material and integrate everyone's information into the case. At that point, students may have encountered new pieces of the scenario and began the cycle again, or they may have brought the case to a close. No matter whether the session was devoted to scenario analysis or research presentations, they all ended with group processing. For a class session scheduled for 75 or 80 minutes, a full half hour was devoted to group processing to ensure every person's full participation. Group processing instructions required each and every participant to provide one single piece of feedback to each and every participant (including themselves) on their performance that session, and no piece of feedback should be repeated (i.e. it must be unique feedback). Participants would take turns providing this feedback until everyone had a chance to go. No specific instructions were given to document written feedback as it might arise through a session, but this practice was modelled by the instructors taking their own notes throughout each session. Early in a seminar, these group processing sessions would often be difficult, with students unprepared or unequipped to provide feedback to their peers or themselves. However, with practice and feedback their capacity to group process improved over the semester.

In the context of enquiry-based learning, facilitators were full and active participants in group processing by giving and receiving feedback from every student in every class session. Their responsibilities included modelling how to give and receive balanced constructive feedback openly and without defensiveness. It was critically important that facilitators received constructive criticism from their students without reverting to instructor privilege or authority. Virtually the only supervisory function of the facilitator was to ensure that group processing occurred at the end of every class meeting, with sufficient time set aside for full participation by each group member. This was particularly important in the early days of a course when students were uncomfortable with the

process. As the semester unfolded, that responsibility became shared as students became more comfortable, valued group processing, and assumed responsibility for it. Thus, in the initial stages of a course, the facilitator was a guiding participant with the goal to become an equal member of the group, as opposed to a moderator or authority. Facilitators also guided students to think about group processing as an essential aspect of the learning experience, one that is ongoing and extends beyond the classroom. For example, feedback and suggestions for improvement informed students' subsequent behavior. When providing feedback about themselves, students often referred back to earlier feedback and upon how they had implemented improvements.

In summary, for the purpose of this study, group processing embodied five key characteristics. First, group dynamics were non-hierarchical by granting all group members with equal voice in providing and receiving feedback. Second, students provided ongoing feedback each session to every group member in order to foster their processing skills. Third, group processing consistently lasted about one third of each session (i.e. 30 minutes of a 80 minute session). Fourth, students provided public, in-person feedback verbally to ensure mutual accountability. Last, consistent with EBL pedagogy, students were encouraged to offer novel contributions to guarantee feedback relevancy.

Group processing was an essential and integral part of every EBL class session. Instructors who engage in collaborative learning, as widely construed, have not agreed on mechanisms to assess group functioning (Johnson et al., 1998). On one hand, it appears that small groups become cohesive and high-functioning because of their size. On the other, we as instructors have observed that enquiry-based learning seminars that used this rigorous and regular form of group processing, without deviation from the structure and format, seemed to have a positive impact on students' learning outcomes and learning experience. Small groups alone are not a panacea. Rather, the specific form of group processing that we have implemented may be an effective assessment mechanism that facilitates the development of high-functioning, cohesive groups and enhances students' academic experience. Implemented in this way, group processing may be an impactful pedagogical tool, and indeed a critical component of EBL. Therefore, the aim of this study is to analyze retrospective feedback of students who experienced an enquiry-based learning seminar in the first year of university studies that incorporated regular and rigorous group processing. Our study does not attempt to isolate and evaluate specific elements of group processing; rather, this preliminary work sought to provide a global initial account of the impact of regular and rigorous group processing on students.

METHODS

Study Design

We implemented a mixed-methods study design to describe student perceptions of group processing in enquiry-based learning seminars. It examined how these perceptions changed over the length of a semester, and if the skills developed through group processing were transferable to other contexts. For this study, we used a convergent parallel design to conduct one online survey (Creswell, 2014). In other words, we collected both quantitative and qualitative data during a single data collection cycle. As part of the analyses, we synthetized both data bodies into an overarching interpretation in order to illustrate quantitative results with complementary, in-depth qualitative data (Creswell & Clark, 2007). Given that both kinds of data examined the same underlying construct (i.e., student perceptions of group processing) across time and domains, the convergent parallel design was the most appropriate fit for this preliminary and exploratory study.

Participants

To be eligible, participants must have completed an enquiry-based learning course during their undergraduate program. Recruitment methods included social media, email from instructors who were still in contact with their students, as well as snowball sampling (i.e., participants were asked to recruit others whom they knew). Forty-six individuals completed the anonymous online survey, and are described in Table 1. All of the participants had attended the university and completed an enquiry-based learning seminar between 2003 and 2016. Out of all respondents, 18 (39%) were still enrolled in higher education. Demographically, 39 respondents (85%) were women and 7 (15%) were men. Five respondents (11%) had switched academic programs while in university. A broad cross-section of programs and disciplines were represented (e.g., 35% Bachelor of Arts, 28% Bachelor of Science, 22% Bachelor of Arts and Science, 9% Bachelor of Commerce). In terms of further education, 28 participants (61%) had graduated with a baccalaureate degree, 18 of whom (64%) had proceeded to an advanced academic program, although specific programs were not identified. Some respondents were temporally near to their enquiry-based learning experience while others were further removed and had taken their seminar as many as ten years previously. This provides a crude yet initial longitudinal approach to the assessment of the impact of group processing, something that has previously been identified as a lacuna in the research (Jones, 2002).

Demographic characteristic	Participants (%)
Gender	
Men	15
Women	85
Enrolment status	
Graduated	61
Enrolled in Higher Education	39
Degree	
Bachelor of Arts (BA)	35
Bachelor of Science (BSc)	28
Bachelor of Arts and Sciences (BAS)	22
Bachelor of Communications (BComm)	9
Highest education level	
Bachelor's Degree	61
Advanced Academic Program	39

Table 1. Overall sample demographic characteristics (N=46).

Procedure

A link to the online questionnaire was provided to eligible participants, which contained an even mix of closed- and open-ended questions. Closed-ended questions measured participants' perceptions of value of group processing, degree of transferability of skills gained from group processing, effect of group processing on learning and overall university experiences, and self-perception of effectiveness in giving, receiving, and implementing feedback during and after the seminar. To evaluate these, a number of Likert-type questions were asked using a 10-point scale from 1 (e.g., completely disagree, totally ineffective) to 10 (e.g., completely agree, totally effective). Open-ended questions asked participants to describe their experience and perceptions of group processing and its impacts (e.g., "Describe one or two moments in the feedback process that you remember" and "Is there one anecdote or significant experience in group processing that you still remember? If so, please share.") as well as to expand qualitatively on quantitative responses (e.g. "If your view of group processing changed over time, can you explain why?" and "How did you feel delivering and receiving feedback? Did your feelings change over the course of the semester?"). Open-ended responses built on quantitative reports by inquiring about respondents' anecdotes and definitions of group processing, reasons associated with changing perceptions of group processing, experiences with group processing before and after the seminar, ways in which group processing affected university experiences, thoughts on giving and receiving feedback during and after the seminar, and experiences implementing group processing in work contexts.

Analyses

Quantitative data were analyzed using StataSE version 13.1 software. Means are included in-text below within parentheses. Paired t-tests were used to assess differences ($p<0.05$ was considered significant) between evaluations at different times for continuous measures. Descriptive statistics for categorical variables are presented with counts and percentages. The qualitative survey data provided student respondents ample opportunity to reflect upon their experience and share their perspectives on group processing. Qualitative data were analyzed by both co-authors to identify key themes across participants. Co-authors iteratively reviewed both qualitative and quantitative findings to highlight convergences and tensions in the two data sources. Quotations from surveys are unedited and are followed by participant's graduation year or current level of study in parentheses. This research received approval from the University Research Ethics Board (status certificate: #13OC033).

RESULTS & DISCUSSION

As shown in Figure 1, most participants "vividly" remembered their group processing experiences (mean=7.4 when rated on a 10-point scale). There was strong agreement that group processing was "time well spent" (mean=8.8). This is an important perspective given that roughly one-third of each class meeting was devoted to group processing. One respondent remarked that: "Because we were a small group it made a huge difference in how we interacted, and this was showcased on how much we supported each as we got to know one another and constantly helped and provided feedback." (4^{th} year student). Contrary to these findings, students in other research on problem-based tutorials have perceived peer feedback as unnecessary and irrelevant (Papinczak et al., 2007; Rodgers et al., 2015).

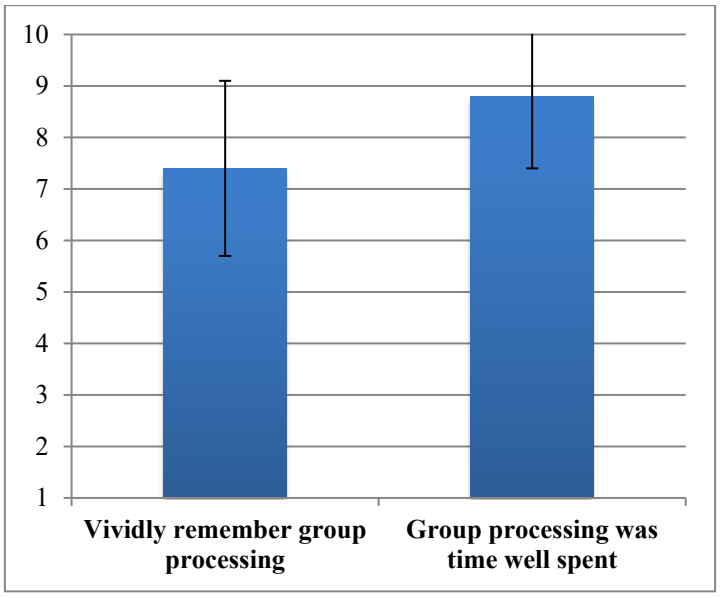

Figure 1. Students' Recollection and Perspectives on Group Processing.

Note: Responses ranged from 1 (Totally disagree) to 10 (Totally agree) for statement "Group processing was time well spent". Responses ranged from 1 (Not at all) to 10 (Completely Vivid) for statement "Vividly remember group processing".

Student participants in our current research also recognized the role group processing played in the improvement of groups and individuals. "At the end of a particularly chaotic session, one student admitted that he felt our team was unorganized. It was the first negative feedback anyone had volunteered. Since then we were more constructive about our performance, pointing out positives AND negatives." (graduated 2016). This is supported by research with other students in problem-based learning tutorials who expressed that peer feedback increased their team-building skills (Kritikos et al., 2011), group performance (Kamp et al., 2013), and confidence in delivering relevant feedback (Geitz et al., 2016). Our participants also strongly agreed that the benefits of group processing continued beyond their seminar and influenced their subsequent university experiences.

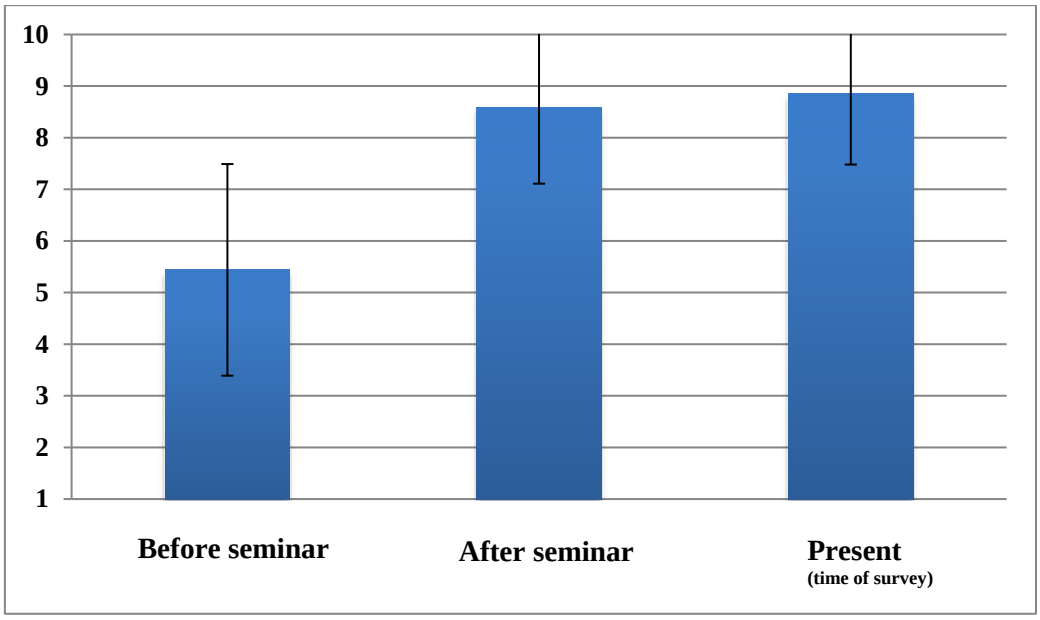

Figure 2. Temporal Comparisons of Students' Retrospective Evaluations of the Importance of Group Processing To Their Learning.

Note: Responses ranged from 1 (Complete Waste of Time) to 10 (Completely Critical to my Learning) for all retrospective evaluations of group processing.

Research has revealed that, at the beginning of a course, students can be hesitant and resistant to group processing (Hung, Bailey & Jonassen, 2003; Johnson, Johnson & Smith, 1998). As shown in Figure 2, our research found that there was a significant increase in how students evaluated group processing as a positive contribution to their learning from the beginning to the end of the course (5.4 to 8.6, $p<0.001$), and from the end of the course to the present (8.6 to 8.9, $p=0.03$). As one participant observed:

> At first it was a somewhat unfamiliar process, and certainly in a class setting. And because we were all new at it sometimes it felt shallow or forced. But as we got to know each other and see the value of group processing, it got much deeper and insightful (graduated 2010).

In a similar vein, another stated: "I remember early on in the course we would dread this process, but as the semester progressed it was something that we developed a deep appreciation of. It challenged us and helped shape our dynamic as a group." (graduated 2009). Another respondent reflected on the typical resistance that can occur when group processing is first introduced: "At the beginning, I felt like we were spending too much time on the group processing portion and that it took time away from the content. But as the program continued, I realized that this time was helping us work more effectively together" (graduated 2011). Similarly, another commented that: "At first I hated it. I had no experience receiving or giving so much critical feedback before. It got better as the

semester went on because I became more comfortable with it, and started to receive it as a way to improve myself/work." (4th year student). The cumulative impact and gradual development of our student participants' comfort and engagement in peer feedback has also been observed in problem-based learning tutorials (Kritikos et al., 2011). Through time and experience, then, even reluctant students came to appreciate the benefits of group processing.

Significantly, 70.3% of participants in the current study reported that they had experience with group processing after the end of their enquiry-based learning course. There was strong agreement that group processing was transferable to other contexts (mean=8.4), including other courses, student clubs, voluntary activities, and personal relationships. For example, one participant noted: "I try to implement group processing when working in group assignments, as I find it makes everyone more open and honest, and ultimately it creates a better final result in whatever we are working on." (5th year student). Another respondent noted that: "Looking back I can see how much the group processing made me develop my skills which I used as a member of boards and groups throughout the following years" (graduated 2011). Another concurred: "I had a leadership position in a university campus group and used group processing to help ensure our members were happy with their roles and event planning" (graduated 2016). Overall, student feedback confirmed that group processing had applicability in multiple academic and non-academic contexts. Importantly, there was agreement that group processing affected the rest of their university experience (mean=8.1), and their experiences after university (mean=7.9). One participant reported that, "it helped me immensely with future group work, as well as living with roommates and communicating with friends" (graduated 2016).

Participants reported improvement in their assessment skills during their seminar course and they related these to their experiences in group processing. In particular, they demonstrated an improved ability to deliver effective feedback to others (mean scores from 7.1 to 8.0, p=0.001). One participant observed that providing feedback to peers also led to improvements in their own abilities. "I initially felt very shy and that I was being too harsh or too cliché with my comments, but with more practice I was (and am) able to more concisely and effectively communicate my feelings with other group members" (graduated 2016). Another respondent reflected on changes in the process and quality of feedback they provided.

> I have moved to being much more specific and constructive with my feedback. I also work hard to give specific examples. This is a shift from giving more general and generic feedback like before. It was never really clearly explained how to provide constructive criticism, but rather it was learned in the process (graduated 2011).

Such observations resemble students' sense of confidence and competence in delivering feedback stemming from peer feedback in problem-based learning settings (Geitz et al., 2016). Moreover, they reveal consciousness of change over time, the superiority of specific versus generic feedback, and of how these skills are learned through practice. Other participants reflected on the depth of the experience and the bonds that were forged through group processing. For example, one stated:

> At first it felt a bit forced to give feedback to each person, but over time as relationships grew it came to feel like an important moment of connection and expression of gratitude. I always enjoyed receiving feedback, especially when it was something unexpected or something that shook my thinking (graduated 2010).

Students also reflected on the complex nature of feedback and its nuances. "I remember…. How much more complicated giving constructive criticism was. One of our members was very adept at both highlighting strengths and succinctly tying in areas for improvement" (graduated 2016). This observation resembles how peer feedback in problem-based learning facilitates opportunities for reflective self-evaluation (Geitz et al., 2016; Papinczak et al., 2007) and enhances the quality of individual contributions (Kamp et al., 2013). Further, it reflects an understanding of the role and nature of feedback and assessment by appreciating the importance to balance the acknowledgement of strengths with encouragement to improve.

Receiving academic feedback from professors and teaching assistants can be stressful for students, especially in the first year of university. They have not always had the opportunity to appreciate constructive feedback as a means to help them improve rather than to diminish their abilities. Initially, group processing can elicit vulnerability; however, the transparency of feedback delivered face-to-face may build an atmosphere of trust among group members. One of the goals of group processing is to help students learn to give and receive feedback openly and without defensiveness. One student revealed a profound change in his/her understanding of feedback, "I've always struggled with feedback. The course, by normalizing the process, really helped move me to a point where I now seek feedback to improve my learning and my performance" (graduated 2011). Another participant reported: "I remember being critiqued for my resources collected. I remember it because it propelled me to be much better with source acquisition throughout the rest of my courses" (4th year student). Others noted that giving and receiving feedback openly led to a realization than people have different evaluations of performance.

> I learned that people often have different perceptions about the quality of work completed, and that my peers often have good comments about what I can improve on. Moreover, my peers' commentary on the positive aspects on my performance made me feel better about working in a team because I felt recognized for my individual contributions (graduated 2016).

Relatedly, students in other problem-based learning research consistently integrated peer feedback in self-assessments to improve their own performance (Dannefer & Prayson, 2013). However, these findings reported that peer feedback compromised harmonious group dynamics. Their participants expressed that overt, negative peer evaluations disrupted working relationships by promoting judgement (Papinczak et al., 2007), defensive reactions (Kritikos et al., 2011), and feared it could become counterproductive (Kamp et al., 2013). Students in other research complained about excessive praise without constructive comments, which led them to perceive peer feedback as unnecessary (Rodgers et al., 2015). In comparison, when rated numerically, participants in our study were more likely to agree that they were more effective at receiving feedback now than during the seminar (7.2 to 8.0, p=0.004), and qualitatively appreciated the variety of benefits that accrued from group processing.

Students can be perplexed about how they should receive feedback or address critiques. In our current research, participants reported that through group processing they became more effective at implementing changes that led them to improve their specific or general performance (7.7 to 8.2, p=0.01). This pertained to areas such as research, analysis, and presentations, or more general skills and behaviors.

> I remember getting the feedback that it felt like I was jumping ahead to conclusions…, which made it hard to follow. This has stayed with me as an insight about how I'm thinking, and how others may be thinking differently, and the dangers of jumping [ahead] too fast without explanation (graduated 2010).

One of the reasons that group processing inspired improvement is that the group would acknowledge changes and recognize individual improvements which reinforced and valorized students' efforts. The students collaborated and developed a group identity that incorporated and facilitated the growth and improvement of each member.

Most participants believed that group processing had an impact not only on their enquiry-based learning experience (mean=8.3) but also on their learning more broadly (mean=8.5). As one respondent observed: "Having it so early in my university career enabled me to gain confidence giving and receiving feedback quickly to be much more

cognizant of how the groups I am part of are functioning" (4th year student). Another stated:

> Once we began to understand its effect on our ability to work through cases, we began to see it as a way to help people take on roles they were less comfortable with and also to balance out the either over eagerness or lack of eagerness of specific individuals. It allowed everyone to take on a leadership role in the group (graduated 2009).

Group processing also provided students with the opportunity to develop new personal insights and behaviors. Most obviously, group skills and teamwork were enhanced. The effect of group processing on developing teamwork skills was also appreciated. One participant made this link, stating succinctly: "It improved my teamwork skills and drive in learning information for knowledge's sake" (graduated 2016). Another drew a link to how group processing bonded the students: "It was hugely critical to understanding where others were 'at' in the group emotionally and in terms of how they were thinking about the issue, and our process. The feedback we generated enabled our group to grow very close and function at a very high level" (graduated 2010).

Students gained significant self-knowledge through the process of self-reflection and seeing themselves reflected back by others. "It gave me a better understanding of my strengths and weaknesses" (graduated 2011). There was also evidence that participants developed greater empathy, "It profoundly informed how I understood how other people think, process information, and feel in social situations" (graduated 2010). Another respondent observed ongoing behavioral changes. "It made me process myself more often, which made for more valuable introspection" (graduated 2012). There were some experiences that linked personal experience and academic interests, "I also learned a lot about my introverted nature. I think group processing sparked my interest in introversion and my ongoing interest in evaluating it in the classroom" (graduated 2011).

Group processing has been found to have a long-lasting impact on students when it was implemented regularly, and the group dynamic was guided by a non-intrusive facilitator. Although this study did not have a control condition with students who did not participant in regular group processing, the quantitative and qualitative findings integrate to articulate strongly the multitude of benefits students clearly ascribed to group processing. The various aspects of self-understanding and transferability of skills are part of the foundation for academic success, especially for first-year students. Respondents provided insight into the transformative nature of group processing and how it prepared them for the future: "It stands out as a significantly empowering and educational experience for me; it made me deeply respect the power of giving and receiving feedback in a genuine way" (graduated 2010). Another shared a significant memory that underscores how

important group processing can be for students to understand their own academic performance and as a practical strategy for how to improve:

> I remember a group processing session early on and the uncomfortable feeling I had when it came to giving my self-assessment. I remember the feeling of coming to the realization that I really had no idea how I was performing in a group setting. … In gaining an understanding of my performance, and subsequently the ability to more critically assess myself, I gained a skill that is now obvious to me that many others never have the fortune to acquire (graduated 2011).

Finally, students underscored not only their appreciation for group processing as a fundamental learning activity and means of assessment, but also for how it opens minds and brings new levels of mutual respect that can only enhance student learning experience.

> I think I had always valued feedback, but didn't recognize the value of it coming from peers. Teachers and professors were the ones with valuable things to say, but I wouldn't have sought out feedback from my own classmates. By having everyone partake in the group processing, it allowed me to change my opinion of the value of both receiving and delivering feedback from peers (graduated 2012).

Despite the reported success of group processing in the First-Year Seminar program, this approach is prone to challenges if careful consideration to implementation and pedagogical adherence are not assured. First, while the public nature of peer feedback ensured students' accountability and responsibility for each other's learning, careful and intentional facilitation is required to ensure it does not suppress constructive feedback among students concerned with hurting others with their comments. Further, if not handled appropriately, public feedback may counterproductively promote tension and disrupt relationships between peers, which are otherwise crucial to the learning process (Kamp et al., 2013; Papinczak et al., 2007). Second, the non-hierarchical nature of group processing allowed students to take ownership of their learning and hone their problem-solving skills, but this should not de-emphasize the importance of the facilitator's role in modelling how to deliver and receive feedback effectively, including on how others may deliver or receive feedback. Students' perceived inability to assess their peers appropriately (Kritikos et al., 2011; Papinczak et al., 2007; Rodgers et al., 2015) may require appropriate facilitator intervention when necessary. Lastly, students' perceived worthiness of group processing in our current study challenges the perceptions of peer feedback as irrelevant in several other previous studies (Kamp et al., 2013; Papinczak et al., 2007; Rodgers et al., 2015). This divergence is an important area for future research,

in order to reproduce our findings as well as to identify the specific components of group processing in our context contrasted with the approaches implemented in other settings that explain these differences.

Importantly, this study also has several methodological limitations. Given that several participants' seminar experiences occurred long before the time of survey completion, the retrospective nature of the questions may have compromised the reliability of temporal comparisons. However, this approach also added depth to our findings by highlighting the potential lasting impact of group processing as a pedagogical tool. Sampling bias is likely given the purposive and convenience approach to reaching study participants; those with more negative seminar experiences may be less likely to remain connected with other students or instructors. Further, our sample may have been affected by self-selection bias. That is, participants who voluntarily completed the study may have been motivated to share their positive experiences with group processing. Thus, we are unsure whether or how much negative or critical perspectives on group processing are underrepresented in our sample. Lastly, our exploratory questions and items began to assess students' ability to deliver and implement feedback; more robust measures of impact on a broader array of outcomes would more reliably assess specific dimensions of group processing that lead to impact. Hence, our results represent a preliminary overall measure of group processing's impact.

Future research should address the gaps in this study. In addition to recommendations above, the association between participants' age (or time since pedagogical exposure) and their perceptions of group processing with a more robust and representative sample should be explored. Further, future research should explore whether unique dimensions of group processing can be isolated to ascertain their associated impacts on student learning to offer a more nuanced evaluation of its components and the causal reasoning behind these changes.

CONCLUSION

Group processing can provide a transformative experience for students. Students consistently reported positive perceptions of group processing, improvement of skills over time, and transferability of skills outside of the seminar context. While an inherent aspect of enquiry-based learning pedagogy, group processing as described in this paper could be employed in other contexts of collaborative and team-based education. If implemented regularly and not subordinated in time and priority to content-based learning, group processing can have a salutary effect on both academic achievement and the personal qualities of listening, receiving feedback, and collaborating that are increasingly demanded by public and private sectors alike.

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How Differences in Motivation and Identification Shape Four Types of Student Experiences with Problem-Based Learning

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ABSTRACT

This article examines why students experience Problem-Based Learning (PBL) environments differently and discusses considerations for improving PBL environments to support a more diverse student population. Based on theoretical perspectives regarding motivation, identification, and learning, we present a new typology consisting of four types of students with distinctly different ways of creating motivation and identity in a PBL environment. While some principles in the examined PBL model motivate and validate certain types of students, the same principles can also challenge identification or result in demotivation among other types of students. Both results are important to consider when developing an inclusive PBL environment. The typology can serve as a theoretical framework for understanding, analysing, and discussing how and why students experience contemporary or new learning environments differently. Additionally, the typology provides a tool for organizations and teachers to motivate and validate students with different type characteristics and improve PBL practices accordingly.

Keywords: Problem-Based Learning, Diversity, Motivation, Identity, Student Types.

PBL AND STUDENT DIVERSITY

A general view on education as a necessary qualification for entering the modern labour marked and a prerequisite for economic growth has supported the development towards a more diverse student population in higher education in many European countries (Gilardi & Guglielmetti, 2011; Langholz, 2014, UKRVU, 2015). Sociological research

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on student diversity has provided valuable insight into issues of access, dropout, completion, and performance in higher education (McDonough & Fann, 2007; Antonio & Muñiz, 2007; Caspersen et al., 2012). Other studies have raised awareness to the challenges so-called 'non-traditional´ students face opposed to ´traditional´ students usually characterized as 19-year-olds, newly graduated from high school, and mostly from families of medium to high socio-cultural status (Gilardi & Guglielmetti, 2011). Social categories such as gender (Søndergaard, 1996), class (Thomsen, 2010) and educational background (Højberg & Martinussen, 2015) give students different prerequisites for navigating the culture and expectations in higher education (Ulriksen, 2009). These insights have emphasized the need for a better understanding of the processes and conditions that hinder or promotes the benefits of a more diverse student population (Chang, 2013; Johannsen et al., 2013).

It has been proposed that Problem-Based Learning (PBL) offers a more inclusive learning environment in higher education (Taylor & Burgess, 1998; Khan & Sobani, 2012). Core principles such as group work and collaboration in PBL seem to enable a process where challenges connected to diversity are gradually reduced (Khan & Sobani, 2012), and students come to regard the ability to cooperate across differences as a valuable social and professional competence (Engen et al., 2017, 2018). Teachers play an important role in facilitating this process of inclusion (Krogh & Jensen, 2020). However, helping students to overcome their differences and merging different experiences with PBL can be difficult for organizers and teachers (Engen et al., 2017). Not least since the majority of the PBL literature and teaching presents PBL as a 'one size fits all' model. PBL may enhance students' motivation but does not always result in autonomous intrinsic motivation (Wijnia et al., 2011) and in fact, students can be motivated quite differently from what teachers expect (Kyed & Pedersen, 2016).

There is a need for further theoretical and practical knowledge of the different ways students experience PBL and why (Krogh & Wiberg, 2013; Engen et. al., 2018). In this article, we examine the following research question: *Why do students experience a problem-based learning environment differently?* We propose that differences in the students' motivation, identification and understanding of learning shape their experiences of PBL. Based on theoretical perspectives on motivation (Ryan & Deci, 2000) identification (Jenkins, 2006) and learning (Ellström, 1996), we identify four theoretical types of students: 1) The Job-Focused Practitioner, 2) The Social Collaborator, 3) The Subject-Enthusiast, and 4) The Directionless Explorer. We examine how these four types have distinctly different ways of constructing motivation and identity around studying Sociology at Aalborg University, Denmark (AAU) as an educational setting based on the principles of PBL (AAU, 2015) and how these differences shape their understanding of

learning and experience with PBL. We then discuss important considerations for improving PBL environments to support a more diverse student population.

This typology not only considers the differences in students' motivation, identification and understanding of learning in a PBL environment, but also how these differences are actively shaped in interactions with their learning environment. By focusing on students' agency and construction of meaning in their learning environment, we aim to understand not just the different pieces in this puzzle, but also the different ways students try to make them fit. This perspective on student diversity gives new insight into the importance of recognizing different ways of navigating and constructing meaning in higher education, which moves beyond merely distinguishing between ´academic´ and ´non-academic´ (Biggs & Tang, 2007) or ´traditional´ and ´non-traditional´ students (Gilardi & Guglielmetti, 2011). If we are to fully understand the complexity of a more diverse student population and improve higher education environments accordingly, we must consider these notably different ways of studying and how they are shaped within in learning environments (Boeskov et al., 2003; Holmegaard et al., 2014; Møldrup, 2018).

DESIGN AND METHOD

The typology was developed as part of a study on motivation, learning and study intensity in PBL workshops at the bachelor programme in Sociology at AAU (reported in Pedersen et al., 2018). Like other social sciences, Sociology does not offer a clear professional profile for a well-defined labour market such as 'psychologist' or 'lawyer'. Therefore, students must make a greater effort to construct motivation and identity in relation to their chosen field of study, and we expected to find different ways of doing so among the students. The following dissemination of the study is based on the COREQ-guidelines for qualitative research (Tong et al. 2007).

At the Sociology programme, the format of workshops varies across semesters and courses. The students will often encounter a variety of PBL practices across the different workshops. Therefore, students continuously need to adapt to and make sense of these changing learning environments, making them interesting places to examine different experiences with PBL. In this study we used a case study design and two courses were strategically selected (Flyvbjerg, 2006) based on significant differences expected to influence motivation and identification in the students' experiences with the PBL environments. This included differences such as semester level, obligatory vs. elective course, full day vs. two-hour workshops, authentic case vs project-oriented assignments, and varying degrees of autonomy and teacher involvement. We selected these cases to achieve the greatest possible variation in a *most dissimilar design*, which is particularly

useful for identifying possible relationships between the studied phenomenon and the given context (Antoft & Salomonsen, 2007).

The case study used method triangulation consisting of in-depth semi-structured interviews with 10 students, participant observations (3 workshops at each course) and questionnaires (84 students answered, 46% response rate). The typology is primarily based on interview analysis and secondary on observations. Since the second author was teaching at one of the studied courses, we took great care in securing students' anonymity and creating a space where students could share both positive and negative experiences with PBL. All interviews were conducted, audio recorded, transcribed, and coded by the first author. The interview participants had answered the questionnaire and signed up for interviews. Before the interviews, the students were contacted by email and informed of the purpose of the interview. One participant chose to withdraw her participation due to time issues. We conducted the interviews in March (Course 1) and October (Course 2) 2017 at the university and they lasted between 40-90 minutes. We interviewed students on their experiences with the course workshops, workshops in general, their overall experience with the PBL model, and reasons for choosing the study programme. Both positive and negative experiences with workshops, as well as a variation of primary type characteristics, are present among the interviewees across courses.

The interviewed students and their primary type characteristics are listed in Table 1.

Interview	Gender	Age	Semester	Course	Primary type (s)	Experience with PBL-workshops
1	W	25-27	6th	1	JP	Negative
2	W	22-24	6th		SC	Positive
3	M	22-24	4th		DE/JP	Positive
4	W	25-27	6th		JP/SC	Negative
5	W	20-21	3rd	2	SC/SE	Positive
6	W	27+	3rd		SE	Positive
7	W	22-24	3rd		SC	Positive
8	W	25-27	3rd		JP	Negative
9	W	20-21	3rd		SE	Positive
10	W	22-24	3rd		DE	Negative

Table 1. Interview participants. Abbreviations: JP: Job-focused Practitioner; SC: Social Collaborator; SE: Subject Enthusiast; DE: Directionless Explorer.

ADAPTIVE THEORY AND TYPOLOGY

Bailey (1994) argues that typologies form a solid platform for both empirical research and theorizing. By reducing complexity, a typology allows us to compare types rather than individual cases. In this study, we developed the typology using the analytical approach of *adaptive theory* (Layder, 1998; Jacobsen, 2007). Developing a typology

using an adaptive approach is a process of mutual influence of both theoretical concepts and data in a dialectic interplay (Layder 1998, p. 77). We used three theoretical perspectives as the framework for the design and analysis, while other concepts were introduced during analysis to refine data emergent themes. These *orienting concepts* and the data were synthesized, and possible new themes or distinctions in the material were identified (Layder, 1998; Jacobsen, 2007).

The three theoretical perspectives in the overall framework were: 1) identification, 2) motivation, and 3) learning. Jenkins (2006) theory on social identity as continuous process of identification, categorisation, and validation was used to understand students' construction of identity in their learning environment. Ryan & Deci (2000) distinction between six types of motivation - ranging from intrinsic to four different forms of extrinsic motivation and lastly amotivation - were used to identify differences in students' motivation. Lastly, Ellströms (1996) four different action-, knowledge- and learning levels were used to identify differences in how the students understood their learning environment and their experience with different levels of autonomy. While individual concepts are presented in the analysis, further description of the theoretical framework can be found in Pedersen et al (2018).

To explore the overall experience of individual students the interviews were initially condensed using text condensation, comparing how and why they differed, and the link between themes in the different experiences. The interviews were then coded in Nvivo 11 using the orienting concepts from the three perspectives as well as emerging themes describing students' experiences with teachers, learning activities, the PBL principles, and reasons for studying Sociology. When needed, theoretical concepts such as facilitator roles (Kolmos et al., 2008) were introduced to refine emerging themes. During the analysis, the research team discussed findings and interview quotes regularly. We compared findings with observations and validated these with other relevant studies.

The developed typology is inspired by Weber's concept '*ideal type'*, which represent a heightened representation of the dimensions within the typology (Bailey, 1994, p. 10). The four student types are an accentuation of the theoretical dimensions and cannot be found empirically in their conceptual purity (ibid.). Additionally, some typical traits are expected to be more pre-dominant than others depending on the empirical context, and may change over time.

A TYPOLOGY OF FOUR TYPES OF STUDENTS

In the following, we present the four ideal types of students with focus on their distinctly different motivations and identifications, views on learning and teacher roles, and

experiences with a PBL environment at AAU (AAU, 2015). Table 2 presents an overview of the four types and their characteristics. In the following analysis, the four types of students are unfolded in detail.

	The Job-Focused Practitioner	**The Subject-Enthusiast**	**The Social Collaborator**	**The Directionless Explorer**
Motivation	Professional possibilities	Academic possibilities	Social possibilities	Unknown possibilities
Identification	Identifies with future job	Identifies with field of study	Identifies with social roles	Lack of identification
Learning	Learning as practice	Learning as formative	Learning as collective	Learning as necessity
Teachers	Teachers facilitates expertise	Teachers facilitates creativity	Teachers facilitates process	Teachers facilitates control
PBL	Transferability in PBL	Autonomy in PBL	Sociability in PBL	Commitment in PBL

Table 2. Four student types and their characteristics.

THE JOB-FOCUSED PRACTITIONER (JP)

The Job-Focused Practitioners stand out due to their strong identification with a future job or career in a practical sense rather than their field of study in general. For these students, the idea of their future professional lives and the process of becoming a professional are essential to how they experience their PBL environment.

Motivated by job goals

With their gaze firmly locked on future jobs, students with the characteristics of the JP evaluate the relevance of individual learning activities and education in general in terms of transferability of knowledge and skills from university to labour market. A student states:

"You need a job. I wouldn't dream of choosing an education for – well, of course it should be of interest to you – but it has to be realistic, I think." (Interview 8)

In a study on how social science students view the relevance of their education, Skardhamar & Baarts (2016) identifies this as 'relevance as skills and generalist competencies' (ibid., p. 109). Because study involvement is considered a mean to increase job possibilities, the JP is extrinsically motivated (Deci et al., 1991). Participating in learning activities is seldom for the sole enjoyment of these activities but rather to achieve essential skills relevant in future jobs. Deci et al. (1991) concept of *identification* describes this form of motivation as guided by personal importance rather than external pressure. It is, however, still goal-oriented (ibid., p. 329) and JPs identify with their future (job) goal rather than the process of getting there.

The future professional self

Since JP's motivation is closely tied to a professional future beyond the educational context, it can be very frustrating and demotivating if the transferability of knowledge, skill or a learning activity is not clear to them:

"(..)when I talk with friends and acquaintances at home – and I all of a sudden use a concept I have learned and think is clever… then they just look at me like: What is she talking about?(..) So, I find it frustrating, that I have all this knowledge and some sort of scientific foundation, but I don't know how to translate it into something I can actually use in the real world with ordinary people." (Interview 1).

As Jenkins (2006) argues, we cannot merely claim an identity; it must be validated by the people around us (p. 44). Therefore, the opportunity to test professional skills and knowledge in learning activities are important to JPs as this serve to validate their future professional self.

Learning by doing

Since JP understand themselves as practitioners, they will prefer practice-oriented courses and hands-on learning activities. By way of contrast, theoretical subjects and abstract discussions are difficult to translate and link to job practice:

"I have difficulties with the abstract stuff (..). It is not my strong side. So mostly – for me – I use the workshops to test if I have understood it correctly or not. And to use it." (Interview 8).

This applied approach and a need for right and wrong answers are embedded in a tendency to understand learning in terms of method directed learning (Ellström, 1996). These students expect to gain procedural knowledge on which to establish rule-based actions. This lets them acquire skills in analysing problems and finding the best approach (or rule) to solve the problem – also referred to as 'know how' (Ellström, 1996, p. 158). Consequently, they regard teachers as 'experts' and expect them to teach the *correct* skills and rule-based choices:

"You learn through feedback. That is where you learn and find out what you have doing correctly and should keep on doing." (Interview 1)

The JP regard these skills as necessary in their future work. Therefore, they expect some repetition across different learning activities rather than continuously introducing something new, as this allows them to test acquired knowledge or skills and put them into practice.

Transferability in PBL

Being highly motivated by future job goals, the JP will gravitate towards certain elements in the PBL environment related to transferability as these elements help them validate identity and stay motivated. PBL principles (AAU, 2015) such as *exemplarity* ensures that students acquire knowledge and competencies applicable in a wider context than the project they are working on (i.e., professional careers). Additional, *authenticity* requires students to work with authentic problems and opens the possibility of cooperating with companies or institutions outside the university. However, some elements in the PBL environment can also lead to *amotivation* (Ryan & Deci, 2000, p. 61). While JPs value teamwork as a relevant skill in the labour market, peer learning in *group work* and *project work* is often devalued in comparison to learning from 'knowledge experts' such as teachers.

"There is no doubt, that it [group work, red.] provides personal learning. It provides personal growth and reflection, all that, no doubt about it. However, it also shifts the focus away from the academic content. (…). If the purpose is for us to learn to cooperate and learn what it is like to be in a workplace – for example – then you must let us know and prepare us for it. And you do not simply do that by letting it be up to ourselves combined with supervision every now and then..." (Interview 1).

Consequently, the JP expects more teacher-driven learning activities and teacher evaluation of their work. This parallels the master-apprentice relationship of *product facilitation* (Kolmos et al., 2008, p. 37), where answers rather than choices are given, but contrasts the principle of *student responsibility* in PBL (AAU, 2015). Therefore, JPs sometimes find the level of autonomy in PBL frustrating and may feel left to themselves when teachers aim to facilitate the student's own assessment instead of providing the answers:

"(..) When it is open-ended like that, then it is difficult to sit there and say: "Okay! What is the right answer, then?" Then you have no idea what the most correct answer was or whether you have made the right decision." (Interview 4)

THE SUBJECT ENTHUSIAST (SE)

The Subject-Enthusiasts' experiences with the PBL environment are shaped by their strong identification with the subject matter or the academic discipline in general. For these students, the academic content is essential and every opportunity to learn more about it and expand their horizon will grab their attention.

Motivated by academic interest

SEs is often intrinsically motivated since their motivation derives from the satisfaction of learning itself (Deci et al., 1991, p. 330). These students are enthusiastic about the academic content and tend to enjoy all activities that hold a learning potential related to their discipline. To immerse oneself, gain new knowledge and transform one's way of thinking is often articulated as the main reasons for attending university:

"I like becoming smarter. I just think everything is fascinating... It gives me something – getting to that point: Ahh, that's how it is! I think that's really cool – to get an understanding of things." (Interview 9).

Since the prospect of new insights drives these students, they are willing to question both existing understandings within the discipline, their own assumptions, and their learning environment. In their view, critical reflection and new knowledge create tangible changes in their understanding of the world, within their field of study, or in society in general. Therefore, the SEs will regard the relevance of education in a formative manner: as an opportunity to make societal changes or transform one's way of looking at the world (Skardhamar & Baarts, 2016, pp. 107-108).

The knowledgeable self

SEs are more pre-occupied with the academic content than the social dimensions of student life. Their identification revolves around the pursuit of lifelong learning and their formative transformation into the academic discipline. As a result, they identify themselves in opposition to students who are more focus on short-term goals:

"I have heard others say: "But I am not going to use it in the project work, so why should I participate?" And in my opinion, it is not just the project you should have in mind. They are very exam oriented. (..) My point of view is that I may not use it right now, but it is part of my education, so I might use it later." (Interview 9)

Instead, SEs find validation in teachers and other representatives of their field of study as well as fellow students who share their level of academic interest. By way of contrast, SEs find other students' lack of academic interest both uninspiring and demotivating. This might cause some SE to concern themselves with how these representatives perceive

them, but they often prioritise the prospect of new knowledge over their academic performance in learning situations.

Learning new things

Because these students find learning and new knowledge highly motivating, they are actively involved in different types of educational activities and subject areas. However, to catch the eye of the SE these activities must hold new learning potential and spark their academic interest:

"If you want to learn something you have to have some element of interest and motivation. Therefore, it is no use just being handed an assignment. Of course, it might be good practice, but if it has your interest and you are committed, then you will learn a lot more." (Interview 6)

The SE is highly reflective in their own learning process and see both possibilities and limitations in different learning activities. This makes them quick to decipher new learning activities and assess the potential outcome. Their understanding of learning resembles *creative learning* (Ellström, 1996, p. 153,158) since they challenge themselves to find new ways of approaching problems and appreciate high levels of autonomy:

"You satisfy some sort of interest. (..) You try things out and challenge yourself, so you don't always go for the easy choice or somebody tells you "You should do this". You think for yourself and figure out, what is going on." (Interview 5)

Since these students expect each educational activity to challenge and contribute somewhat differently, it can result in *amotivation* if there is too much repetition from one learning activity to the next.

Autonomy in PBL

The SEs value the principles of *student responsibility* and *autonomy* in the PBL model (PBL, 2015) since they allow for independent choices during learning activities and a more explorative approach to their subject of interest:

"(..)It might be a very concrete assignment, but you can approach it any way you like, or you can choose something else. No one is going to say:" We were not supposed to do it like that!" or something like that. And I think that is a good thing, because… responsibility for one's own learning also means that you are allowed to think outside the box." (Interview 6).

While other students might expect teachers to control and test their knowledge, the SE prefer teachers who challenge existing assumptions and provide new learning opportunities through autonomy. This parallels some of the overlooked benefits of

laissez-faire facilitation (Kolmos et al., 2008, p. 37) as it can facilitate students' own initiative, independence, and creativity. By way of contrast, a more controlling approach from teachers can result in *amotivation* and a sense of restriction for the SEs, since it limits their independent pursuit for new insights and challenges. Instead, they expect teachers to introduce new ways of thinking about the subject through academic enthusiasm:

"There is nothing better than being taught by someone truly passionate about their subject matter and who introduces some interesting considerations:" You could look at it that way, but have you considered this and this?" It must be someone skilled in their field of study, but without being arrogant." (Interview 6)

However, the SE's need of academic validation makes them critical towards the lower priority of *individual* feedback and accomplishment they might experience due to the central principles of *group work* and *collaboration* in the PBL model (AAU, 2015).

THE SOCIAL COLLABORATOR (SC)

The Social Collaborators are socially outgoing and their experiences with PBL-based learning are shaped by their strong connection to the social dimensions of the PBL environment. These students enjoy collaboration with peers, collective learning, and the development of social competencies.

Socially motivated

The SCs find the social aspects of their learning environment highly motivating and these might even be the main reason why they have chosen a selective course, a study programme or even a university:

"I like group work and how you get to apply the concepts when you discuss them - instead of just reading a text, writing a paper and handing it in. Then you haven't really used your knowledge in my opinion (...). I think you get a better result from group work – and it's actually the reason why I chose AAU" (Interview 7)

The SC prefer collective PBL activities such as group work and discussions, since they find collaboration and sharing different perspectives with fellow students rewarding and enjoyable. Like the SE, this makes their motivation resemble intrinsic motivation. However, their motivation often takes the form of *integrated regulation* (Deci et al., 1991, p. 330) as their participation is externally oriented towards gaining social competencies through self-reflection. One student gives an example of these reflections:

"What competences could I draw on from other situations and use in this one? What is working in this situation, in this group, and what other things should I draw on in other situations and other groups? That situational awareness and the ability to adjust your behaviour to the situation – instead of always doing the same thing." (Interview 4)

Consequently, these students consider the relevance of their education in terms of a transformation of self. But their social interest may also spark a desire to make a difference – a form of relevance that focus on other people or society in general (Skardhamar & Baarts, 2016, p. 108).

The social self

Unlike JP and SE, the SC identify with social roles in peer groups rather than defining themselves by academic interest or future professions. These students enjoy spending time and discussing with co-students, since it enables them to learn from other people's perspectives:

"In my opinion, you explore more about the topic, when you work together - and it is more fun to discuss it with other people rather than just yourself! (...) I really think you learn a lot by hearing things from all kinds of angles, discussing and really seeing the world as round from all perspectives." (Interview 2)

However, the social sensitivity of SC's makes them particularly preoccupied with their *presentation* of self in social interactions (Jenkins, 2006, pp. 44-45). They can be quite concerned with their performance in educational situations and fellow students' opinions of them; opinions they often value higher than the opinions of their teachers:

"I become very self-conscious and think a lot about how I say things, so I don't sound stupid... I've been in quite ambitious groups, and it's fine, because you learn a lot in those and we have some really good discussions, but I almost get sweaty palms and think to myself: "Now you have to contribute with something clever!" (Interview 7)

This might be especially evident in a PBL environment predominately based on group – and project work where the boundaries between the social and educational context are blurred, making it difficult for students to navigate and maintain a distinction between different social roles.

Learning with others

The SCs' understanding of learning is shaped by their motivation and identification with the social dimension of their learning environment. They regard learning as a collective achievement, and value and understand the importance of other peoples' perspectives in the learning process.

"You get different input, and you might say:" Oh, you think of it that way, I thought of it this way, but maybe we can do it in a totally different way or combine our suggestions?" You must be constructive and be able to look at it differently than your own point of view. That is what I like about group work – more angles to view the same thing." (Interview 5)

Therefore, SCs will often understand learning in terms of *problem-directed* learning (Ellström, 1996, p. 158). This type of learning allows for situations and problems to be assessed and analysed (collectively) from different perspectives drawing on prior experiences and theoretical knowledge leading to new ways of seeing the problem (ibid.). Consequently, it is easier for these students to connect with the learning *process* than the *content,* and they prioritise learning activities that hold potential for collaboration, co-creation and improving social competencies.

Sociability in PBL

The SCs understanding of learning as both collective and problem-oriented corresponds well with the PBL model at AAU (2015). The SCs find the principles of *Group Work* and *Collaboration* especially motivating, because these students prioritise and appreciate activities that allow for the social interaction with fellow students and teachers. They experience positive benefits from group-based learning activities that contribute with knowledge and experiences not attained from, for instance, individual preparation and lectures. However, while group work and collaboration are motivating, it also holds the risk of becoming a source of *amotivation* (Ryan & Deci, 2000, p. 61), since these students are particularly vulnerable to group dynamics and lack of attendance:

"It was not really motivating to attend, because you knew: The others are not going to show up, so who I am going to work with, and I wonder if anybody else is going to be there? Am I going to squeeze in somewhere or just sit and work alone?" (Interview 5).

The SCs vulnerability to social dynamics makes teachers ability to create a socially comfortable learning space important to these students. They expect teachers to *facilitate the process* (Kolmos et al., 2008, p. 37) of the group and ensure good cooperation and discussions rather than give the answers:

"I think it's about giving subtle clues without providing the answer. Because sometimes we are stuck and we don't know which way to go (..) So you just get a little help to get on your way and advice on how to do it well. Not necessarily the answer, because we have to figure that out ourselves." (Interview 7).

THE DIRECTIONLESS EXPLORER (DE)

While some students identify with ideas of future professional selves or the field of study in general, others lack such identifications. Instead, The Directionless Explorers are characterised by random orientation, recurrent doubts, and short-term goals, which shape their experience of PBL environments.

Motivated by expectations

The DEs choice to enter higher education is primarily influenced by societal opinion on the importance of higher education. These students view education as a necessity to do well in life but lack a personal goal or incentive in their choice of study - a possible flipside to these strong societal expectations. Since the DE act according to the (perceived) expectations of others their motivation resembles *introjected regulation* (Deci et al., 1991, p. 329), and they often participate in educational activities, because they believe the educational institution or fellow students expect them to:

"I think you are obligated to attend, because you don't want to just leave it to the others. Then it's just two people sitting there and everyone else didn't show up." (Interview 10)

Like the JPs, they regard the relevance of education in terms of *skills and generalist competencies* (Skardhamar & Baarts, 2016, p. 109). However, rather than ascribing the relevance to *long-term* job goals, they concentrate on *short-term* goals such as a project or passing an impending exam.

"You are always thinking that you just have to get through the next and then the next. (..) I almost think that this is all there is to it. To university. Just exams – from one to the next." (Interview 10)

By way of contrast, students with the characteristics of SE and SC are motivated by the learning *process* - not the *result*. This makes the DE the most externally motivated of the student types and their motivation can even take the form of *external regulation* (Deci et al., 1991, p. 329) as their focus on passing exams lacks a meaningful connection to their sense of self.

The unknown self

While other student types identify with professional, academic or social dimensions of the educational environment, the DEs have not found such identification yet. They may have ended up at their chosen study programme by coincidence, but they entered with the hope of sparking a genuine interest:

"I had imagined that two years in, Sociology would have been my preferred recreational activity. But it's just like high school – it's school and it is work. It can be interesting at times especially if you spend a lot of time with it, but most of the time it's boring to sit and read." (Interview 3)

Since DEs have yet to find this spark, they are continuously searching for something that resonate with them and grabs their attention. As a result, DEs will participate in many different learning activities as they explore the possibilities of self. However, their lack of self-determination and direction makes them susceptible to the influence of others and they are often marked by doubts in their choices.

Learning as necessity

The extrinsic motivation and lack of identification makes it difficult for DE to ascribe purpose and meaning to learning activities. Instead, learning becomes necessary to reach short-term goals and avoid negative consequences such as failing an exam. Subsequently, they judge the importance of learning activities on their connection to exams:

"This is not important to learn, because I'm not going to need it for the exam. Or there is a very small chance, so it is not important to me. (..). So I think exams takes precedence when you are considering whether you're going to participate or not." (Interview 10)

As a result, the DEs perspective on learning resembles *reproductive learning* (Ellström, 1996) since these students understand knowledge in terms of right and wrong answers and prefer repetition between learning activities to test this knowledge. Consequently, they expect teachers to confirm whether the academic content is understood *correctly*, since they find it difficult to make that assessment themselves:

"(..) It can be demotivating when you do not get any response to what you are doing.. It sometimes seems that there is no reason to do it when no one tells you if it is right or wrong." (Interview 10)

Commitment in PBL

The DEs find it hard to navigate in PBL environments and they are prone to *amotivation* (Ryan & Deci, 2000, p. 61) without clear teacher guidance and structured study activities. The DEs find it difficult to live up to the principles of *student responsibility* and *autonomy* in the PBL model (AAU, 2015) because they continuously doubt their own choices and rely on others' expectations to stay motivated. Teachers often play a major role for DEs in terms of *control facilitation* (Kolmos et al., 2008, p. 37). They expect teachers to set clear expectations, correct them if they do not meet these expectations, and explicitly state the purpose of learning activities:

"I miss being told why we do what we do. In general, both with these exercises, lectures, etc. – just in general to be told why it is important." (Interview 10)

For Des the principles of *problem orientation* and *project work* offer the possibility to try out different approaches to problems and explore different subject areas that might spark interest or guide them onwards in their search for identification in the study programme. The social commitment in *group work* can also help them stay motivated, but the lack of personal incentive leaves the DE vulnerable to the whims of fellow students as they look to others for motivation:

"If I knew my group was attending, I would definitely come no matter what it was - just to be a part of it. (..) However, if none of the others come, then it may not be that important. If the others get through without that exercise, I can probably also get through without that exercise." (Interview 10)

STUDENT MOTIVATION AND IDENTITY IN PROBLEM-BASED LEARNING

The increased diversity of the students entering higher education –together with other external demands- challenges the PBL model (Bøje et al., 2020). A more diverse student population means higher demands on the coordinators, teachers and learning environments to insure the outcome of problem-based learning. The four types of students identified in this article - with their distinctly different ways of connecting with and experiencing a PBL environment - indicate that there is no universal way to enhance motivation and identification among students in PBL environments. The typology can serve as a tool to help organizers and teachers understand, examine, and discuss how and why students experience PBL environments differently and which actions should be taken accordingly. In the following, we discuss important considerations for improving PBL environments to support a more diverse student population.

Students identify with PBL in different ways

Students have different ways of identifying with their learning environment (Holmegaard et al., 2012, 2014; Johansson et al., 2020). We find that students may construct identity around the academic, professional, social or even unknown possibilities of higher education. This study adds to the existing literature by highlighting the dual aspect of validation and vulnerability in the different principles of PBL, and the different meaning and importance they have for students' identification. Students, who identify with the academic dimension of PBL, will perceive principles such as group work as an opportunity for challenging academic discussions, while others, who identify with the social dimension, see group work as a chance to develop social competencies. Problem-based learning activities are multidimensional. Therefore, it is important to ensure that

dimensions are balanced when planning PBL activities in order to establish a more inclusive environment. This includes normalizing uncertainty and doubt, and creating opportunities for the students to explore potential areas of identification. Teachers and organizers should include the different ways students identify with their learning environment in evaluations to identify underrepresentation of particular dimensions and gain knowledge of mixed experiences with learning activities. Additional, PBL principles such as group work can be both the source of validation and vulnerability concerning students' identification as seen in the SC's sensitivity to social dynamics. This duality is important to consider when introducing new practices such as workshops or online teaching that may emphasise different dimensions and possibilities for identification. These findings may help to explain the mixed experiences with online teaching during COVID 19 lockdown (Haslam et al. 2021), since the lack of social interactions may have been especially difficult for students with SC characteristics.

The principles in the PBL model motivate students differently

Increasing motivation in PBL environments is no simple task. The typology shows how differences in identification influences students' motivation and experiences with different principles in the PBL model. While some principles greatly motivate certain types of students, they may result in *amotivation* among other types of students. This dual aspect of PBL is important, since any one-sided effort to enhance some PBL-principles at the expense of others may result in *amotivation* among some students. Similarly, Boeskov et al. (2003) find, that efforts, which may help to retain some students can be the cause of dropout for others. This paradox of student diversity is evident in the student types' different views on principles such as autonomy and student responsibility, and how these differences result in different teacher expectations. According to Ellström (1996), a high level of autonomy will enable knowledge-based and reflective learning which are considered key outcomes of PBL. Yet, where some student types look to their teachers for inspiration and guidance, others expect expertise and control. This may explain why other studies find, that PBL not always leads to intrinsic motivation, and the need for finding the right balance between scaffolding and autonomy in PBL environments (Wijnia et al. 2011). To create a more inclusive learning environment, teachers must be able to navigate different roles of facilitation (Kolmos et al., 2008), but also communicate clearly what students can expect and why. This may require extra education in PBL teaching and highlights the dialectic relationship between student characteristics and situational influences in student motivation.

Student types are dynamic and may change over time and in different contexts

We agree with similar studies (Boeskov et al., 2003; Møldrup, 2018) that the different types must be understood as dynamic and not static categories. The typology is a valuable analytical tool for understanding the empirical complexity of student diversity where

student types will exist simultaneously - both in individual students and within student groups – and prominent type characteristics may change over time and contexts. For instance, the directionless characteristic may be more prominent in first year students and towards the last year be replaced by other types such as more job-focused characteristics. Additionally, some student types may be more represented at some studies than others. Students' construction of identity is an ongoing process and something that study programmes can support (Holmegaard et al. 2014). Organizing PBL activities accordingly, could help students in this process. However, doubts may also occur - and eventually result in dropout - if students feel they do not match the assumptions that constitutes 'the ideal student' in their learning environment (Sarauw & Frederiksen, 2020). Though PBL may offer a more inclusive learning environment in higher education, it is necessary for teachers and organizations to acknowledge how not just higher education but also *PBL* environments shape and favour certain types among students. As Boeskov et al. (2003) argues, higher education environments risk losing otherwise gifted students if they choose to focus their effort on a single student type. Creating a more inclusive PBL environment involves active discussions among faculty on diversity in ideas of 'the ideal PBL student' and making sure this diversity is communicated to students both explicitly and through the organization of PBL activities that accommodates different student types. However, further research is also needed to help support this effort.

LIMITATIONS

The typology was developed using qualitative methods based on participant observation and 10 semi-structured interviews with students from 3rd, 4th and 6th semester in Sociology at AAU. First year students might have provided more insight into the doubts of the directionless explorer, as we expect this type to be more prominent in the early transition into higher education. However, later semesters where selected as they were expected to provide more well-defined student types and more well-established identifications with the study programme. We conducted interviews with students who –with variations- regularly or always participated in the workshops. The analysis does not include students who seldom or never participate, and we are unable to say whether they share the characteristic of those who attend workshops. However, among the interviewed students we were able to identify both motivation and amotivation. This specific typology may be limited to Sociology and similar disciplines, where there is no clear and well-defined professional profile for students to identify with. However, the student types identified in this article resembles types found in other studies across different courses, study programmes and universities. The main part of the interviewed students are women, which reflects the gender distribution at the Sociology programme. However, the unequal representation of gender is a limitation in the generalization to student populations with

a different gender distribution. Lastly, we conducted the study at AAU with a learning environment based on the principles in the AAU PBL model. The principles in this model may vary compared to other PBL environments.

CONCLUSION

In this article, we offer a new typology of student types considering not only differences in student motivation and identification with their study programme, but also how this tie into different ways of understanding learning and experiencing PBL environments. The four theoretical types identified have distinctly different ways of connecting with and experiencing PBL environments. These types are: 1) The Job-Focused Practitioner, 2) The Subject-Enthusiast, 3) The Social Collaborator, and 4) The Directionless Explorer. The student types identified in this article bare some resemblances with other types identified by related studies, which indicates similar diversity in the student population across different courses, study programmes and universities. This article adds to the existing PBL literature by highlighting the dualism of PBL as source of both motivation and amotivation; validation and vulnerability. The typology offers a way of understanding student diversity beyond the distinction between ´academic´ and ´non-academic´ (Biggs & Tang 2007) or ´traditional´ and ´non-traditional´ students (Gilardi & Guglielmetti, 2011). Instead, we contribute to a more dynamic and situational perspective where teachers, fellow students and the PBL environment are co-creators of students' motivation and identification.

In the discussion, we highlight three important aspects of student diversity for teachers and organizers to consider: 1) Students identify with PBL in different ways. They may identify with the academic, professional, social, or even unknown possibilities of higher education or a mix of these. This multidimensional aspect should be considered to accommodate different meaningful ways of identifying with PBL environments. 2) The principles in PBL motivate students differently, and the same principle may cause amotivation in some students while enhancing motivation in others. Teachers and organizers should consider this when evaluating and improving PBL practices to avoid any one-sided efforts to enhance some principle over others. 3) Student types are dynamic. Students may have multiple type characteristics, and they may change over time and in different contexts. Future research should focus on how PBL environments cultivate and possibly idealise certain student types over others.

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Evaluation of the Problem Based Flipped Classroom Instruction Process in the Framework of Community of Inquiry

Mustafa Serkan Günbatar *

ABSTRACT

The aim of this study is to determine the effectiveness of the instruction process through the use of the PBFC model within the scope of the CN&C course. The evaluation of the PBFC process was made with the qualitative data obtained from the participants within the scope of CoI. Within the scope of cognitive presence, the participants firstly talked about the fact that video-based materials started the learning process. Within the scope of social presence, they talked about the contribution of PBL activities to motivation and a respectful communication environment. Within the scope of teaching presence, participants firstly mentioned the fact that PBL activities deepen the meaning of the subject. Within the scope of learning presence, participants talked about the increase in their self-efficacy regarding course content, the formation of regular study habits thanks to video-based materials, and they stated the fact that their intrinsic and extrinsic motivations stayed alive.

Keywords: Flipped classroom, Community of Inquiry, Problem based learning, Computer Networks and Communications course, Pre-service teacher training.

INTRODUCTION

The instruction process is also a communication process. In the traditional approach, this communication occurs in the form of the teacher presenting the information and the students receiving and absorbing this information. In a more contemporary dimension, the instructional communication process is shaped according to the changing roles of teachers and students. The quality of the communication established in the focus of the

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course content can increase the efficiency of the instruction process at the same rate. Creating an instruction content, goals are determined primarily. Goals shape instructional content. Therefore, the content that is in focus on the instructional communication process can be grouped mainly as cognitive, affective, and psychomotor.

Turkish Council of Higher Education (CoHE) sets the framework of the course content at the higher education level in Turkey. Within the scope of Computer Education and Information Technology department (CEIT) in Education Faculties, students take a Computer Networks and Communications (CN&C) course in their third year. The course content covers the issues related to how communication is provided in the Local Area Network (LAN) and Wide Area Network (WAN) environment (CoHE, 2007; CoHE, 2018). The course content includes cognitive, affective, and psychomotor contents. Within the scope of the course, students encounter new technical terms and abstract concepts. When necessary, they are supposed to practice implementations. Therefore, being prepared for the lesson is one of the important variables for the success of the instruction process.

Flipped classroom (FC) has a flexible structure. In this way, many different models have been developed with different perspectives regarding its implementation (Gómez-Tejedor, Vidaurre, Tort-Ausina, Molina-Mateo, Serrano, Meseguer-Dueñas, ... & Riera, 2020). The starting point here is the idea that in-depth learning can be achieved with active learning (Konijn, Essink, Buning & Zweekhorst, 2018). As a result of the implementation of an appropriate FC model, it has been observed that active learning in different disciplines including theoretical and practical activities becomes easier (Chuang, Weng & Chen, 2018). In order to get effective results at the point of active learning, it is important to have a link between theory and practice. Therefore, it is recommended to prefer appropriate pedagogy in the FC process (Zheng, Bhagat, Zhen & Zhang, 2020). From a pedagogical point of view, students can be directed to collaborative activities in FC processes (Winter, 2018). With the use of collaborative learning, inquiry-based learning (IBL), and problem-based learning (PBL), the effectiveness of the FC process can be maximized (Zheng, Bhagat, Zhen & Zhang, 2020). For instance, as a result of the FC processes performed with PBL where group work was preferred, more effective results were obtained only in favor of the traditional FC process (Chis, Moldovan, Murphy, Pathak, & Muntean, 2018).

Technology integration into the FC process is also easy. Positive results can be achieved with Information and Communication Technology (ICT) tools, which are appropriately used to improve student learning (Rasheed, Kamsin & Abdullah, 2020). These results can be in the form of students' ability to easily access course content and communicate with instructors and friends (Kayaduman, 2020). These technologies to be preferred should be user-friendly as well. Otherwise, the effort to be spent on learning may shift from learning

content to learning the use of technology (Bakla, 2018). Considering today's conditions, social networks should not be ignored at the point of using ICT. Because the use of social networks is an effective way to create a sense of community (Karaoglan-Yilmaz, 2017) and social network content can be easily accessed via smartphones.

The FC process, which is basically based on performing classroom activities at home and doing homework at school, was initially implemented at the high school level (Bergmann & Sams, 2012). Over time, it has been implemented in different education levels. It is recommended to conduct FC processes in various disciplines (Lee, 2018; Jdaitawi, 2020; Yoon, Kim & Kang, 2020) by employing appropriate technological tools and pedagogical methods (Rasheed, Kamsin & Abdullah, 2020), obtaining in-depth data through qualitative research (Sergis, Sampson & Pelliccione, 2018; Lee & Kim, 2018; Karabulut-Ilgu, Jaramillo Cherrez & Jahren, 2018; Martínez-Jiménez & Ruiz-Jiménez, 2020; Park & Kim, 2021), demonstrating the quality of communication regarding the process (Lai, Hsiao & Hsieh, 2018; Jdaitawi, 2020; Kayaduman, 2020; Thai, De Wever & Valcke, 2020), and it is recommended to contribute to the literature.

The conceptual framework in which communication is provided through computers at the higher education level, which contains essential elements for success in the education process, can be named *Community of Inquiry* (CoI). Dewey (1959) stated that the educational process has psychological and sociological sides. From this point of view, CoI was designed with cognitive and social elements. With the responsibility of designing and integrating the cognitive and social dimensions, one core element was also added. These elements can be named as *Cognitive Presence, Social Presence*, and *Teaching Presence* (Garrison, Anderson & Archer, 1999). CoI describes how learning takes place for a group of individual learners through the educational experience that occurs at the intersection of social, cognitive, and teaching presence. This can be used to provide detailed insights concerning the design of the teaching activities. In addition to these elements, *Learning presence* can also be mentioned (Shea & Bidjerano, 2010). CoI occurs as a result of online communication. CoI framework is mainly used for the evaluation of instruction processes in online and blended learning contexts (Garrison, Cleveland-Innes & Fung, 2010). *Cognitive Presence* is concerned with constructing meanings during communication processes (Garrison, Anderson & Archer, 1999). *Social presence* is related to the ability to establish personal and logical relationships (Garrison, 2007), it can be defined as the ability of a person to reflect himself socially and emotionally like a real person in the environment where communication tools are used (Garrison, Anderson & Archer, 1999). *Teaching presence* covers the responsibilities of the teacher in the communication process (Stenbom, 2018). *Learning presence* includes situations related to self-regulation (Shea & Bidjerano, 2010).

Based on the above-mentioned situations, this research has been planned with the idea of ensuring that students come prepared for the CN&C course, which includes technical terms and abstract concepts, and to increase the efficiency of the process with in-class interactive activities. So the aim of this study is to determine the effectiveness of the instruction process through the use of the Problem Based Flipped Classroom (PBFC) model within the scope of the CN&C course. Theoretically, the CoI model taken as reference and the effectiveness of the instruction process evaluated accordingly.

METHOD

Instruction Process

Instruction activities applied through the spring semester of the 2019-2020 academic year. Instruction activities are carried out within the scope of the CN&C course. The course content is intended to develop learners' understanding of the communication process of computers in a network environment. Within the course, many new technical terms and abstract concepts are encountered. Therefore, it is important for learners to come to class be prepared.

In total, 4 weeks of instruction were provided. Face-to-face instruction activities (i.e., PBL activities) are carried out every week. After the face-to-face instruction, the instructional videos of the following week were delivered to learners through WhatsApp. After the video-based instruction materials were sent, the face-to-face lesson process repeated with the PBL method.

PBFC implementation model

In this study combination of FC and PBL was implemented. FC was used for preparation for the PBL activities. PBL was used for reinforcement of learning content. In the FC phase, video-based learning materials were sent to the students. Students got preliminary information from them. After a while instructor asked questions about the video content and then he checked if students watched the videos or not. After the students' replies instructor provided feedback about their answers. The aforementioned activities aimed to prepare for the PBL activities. In the PBL phase, face-to-face communication took place. In total, four problem statements were clarified by the students. In the PBL phase, students conducted group work. In figure 1 all steps of the PBFC are summarised. Step 1 in figure 1 covers the general preparation process carried out by the instructor within the scope of the PBFC model applied in the study. The following steps 2, 3, 4, and 5 cover the implementation model of the FC process, which is implemented weekly within the scope of the study.

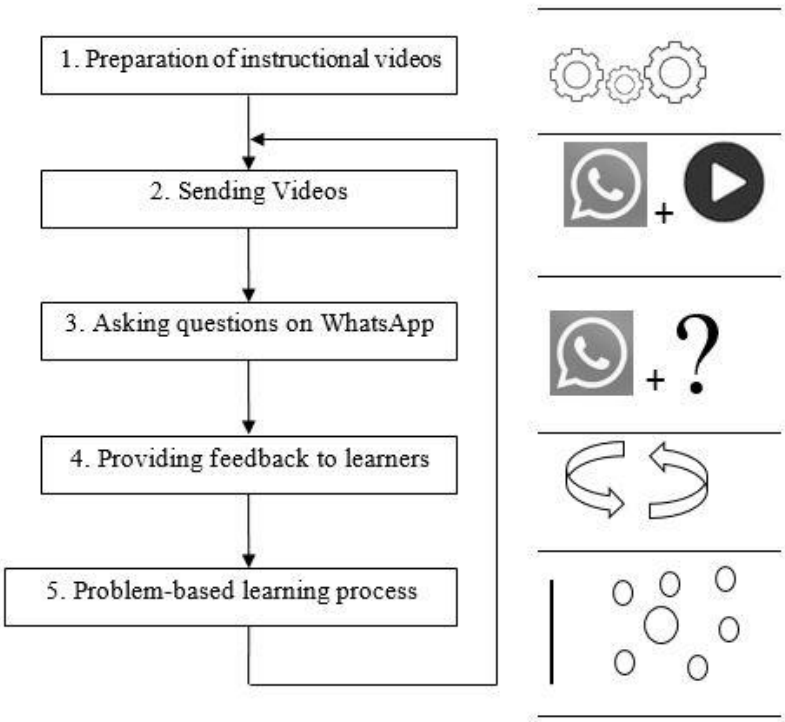

Figure 1. PBFC model applied in the study.

1. Preparation of instructional videos. Video recordings were 5-10 minutes on average. To make the message to be easily understandable, care was taken to use understandable language in the recordings. A total of 13 video-based learning materials were sent for the four-week instruction process.

2. Sending videos. Videos that will be used in the following week are sent to the WhatsApp group on the same day, immediately after the PBL activities.

3. Asking questions on WhatsApp. On average, 2-3 days after the videos were sent, questions about the video contents were asked. The aim is to check whether students are watching the videos shared and to remind learners who forgot to watch.

4. Providing feedback to learners. Feedbacks were provided to learners' answers.

5. Problem-based learning process. During the face-to-face course process, important points of the weekly topics were emphasized by using the PBL. Four problem situations were used and they are listed above:

PBFC Problem statements

PBL and IBL are two kinds of Active learning. They have common properties. PBL is a special type of IBL (Spronken-Smith & others, 2008). Two of the PBFC Problem

statements are examples of the use of IBL, in that they deal with explaining terminology. The others are examples of PBL.

1st week's problem situation: For an educational institution under construction, internet infrastructure will be provided and a computer laboratory will be established. As a subject matter expert and information technologies teacher candidate, you are asked to provide suggestions about the communication environments that may be needed.

2nd week's problem situation: Three computer labs exist in a higher education institution. The first consists of 40 computers built with coaxial cables, the second is 40 computers built with UTP type cables and MAU (Multistation Access Unit), and the third contains 40 computers built with STP type cables and a switch. Management considers allocating one of the laboratories to the students for 1 hour per day, another for the lessons they will need to access the data by using the internet, and the remaining one for the applications they will design through the computer. The institution is in a position to allocate some budget for some new regulations when necessary. At this point, suggestions are requested from you.

3rd week's problem situation: Alican is a high school student who is interested in electronics and computers. Aware of this, his family bought him an Ardunio set so that he can spend his spare time. Alican has started to practice implementations by adding various components to the Arduino board, which has electronic circuits. But there is something that pervades his mind and cannot find an answer. How is the Arduino card, which consists of electronic circuits, able to communicate with its computer via a cable and execute commands? Alican has heard that you are an information technology teacher candidate and would like to consult you on this matter.

4th week's problem situation: Ferhat is a student who takes the computer networks and communication course, however, he does not attend the course regularly for some reasons. He has mislearning about how communication takes place in local area networks. He confuses the purpose of using addresses such as MAC address and IP address and does not fully grasp the logic of which network devices should be evaluated at which layer of the OSI model. The midterm exam is approaching, and as a friend, Ferhat is waiting for your support as he prepares for the exam.

The Study Group

The study group consists of pre-service teachers studying in the Faculty of Education at Van Yüzüncü Yıl University in Turkey. They are juniors at Computer Education and Instruction Technology department in the 2019-2020 spring semester. With four pre-service teachers (i.e., learners) CN&C course was conducted according to the PBFC model.

Data Collection

Because of the small group of pre-service teachers who were enrolled in the course, the qualitative data collection method was preferred. This is a case study. A structured interview form was created with reference to the CoI model and it was used. In the interview form, there are four main questions and 13 sub-questions directed to determine Cognitive, Social, Teaching, and Learning presences (see Appendix: PBFC Interview Questions).

FINDINGS

In this section categories and sample expressions are presented regarding to cognitive, social, teaching, and learning presences. Interviews were conducted in Turkish, then they were translated into English. At this point, maximum attention has been paid to ensure that the meaning does not change.

Findings related cognitive presence

Analyses regarding cognitive presence were conducted within the framework of *Triggering Event, Exploration, Integration, and Resolution* themes, and the relevant categories were determined. The categories for each theme, how many students responded to these categories, and sample expressions are presented in the tables below.

Category	*Frequency*	*Sample expressions (S: Student)*
Pre-lesson preparation	4	S1: I got prepared better for the lesson thanks to the videos provided before the lesson. S3: Our lecturer sends us questions every week the following days after these videos. To find the answers to these questions, we either look at our notes from the videos or watch the video again and answer the questions.
Being active in face to face classroom environment	1	S1: Video-based materials offered the opportunity to be more active in the lesson. It allowed me to understand the lesson more efficiently. It made me love the lesson more and increased my interest in the lesson, and it provided me with the opportunity to see my shortcomings in the lesson and to make up for it.
Positive attitude towards the course content	2	S2: Since the topics to be learned in the videos are presented in a fluent and instructive manner, I was excited about what the topic would be each week. The implementation of an instructional design in this way increased my interest and enthusiasm for the lesson.
Full learning	3	S2: Especially because of using this method, I have been able to re-capture the parts that I might have missed and to realize full learning by watching the videos repeatedly. Thanks to this, I started to learn the subjects better. S4: Video-based materials were accessible. Being accessible at any time played an important role in detecting the missing information about the subject.

Table 1. Categories and Sample Examples concerning to Triggering Event Theme.

Video-based lectures presented before the lesson were used to start the learning process. It is understood from the expressions made within the scope of the *"Pre-lesson preparation"* sub-theme that it has the expected effect on students. In addition, the students also used expressions that videos provided the basis for *"Full learning"* and played a role in *"Being active in face-to-face classroom environment"* and *"Positive attitude towards the course content."*

Category	*Frequency*	*Sample expressions (S: Student)*
Research on unclear issues	2	S2: While watching the videos, I tried to eliminate the question marks in my mind about the subject by doing research in parts I had difficulty in understanding, especially during the note-taking phase.
Research for additional information	4	S1: I did some research for additional information. It was necessary to be prepared for the lesson in order to consolidate what our lecturer told, and I conducted research to understand the topics our lecturer told and to ensure that the lesson was efficient for me. S3: I tried to learn about some subjects by finding visual content and researching it on the internet. In some, I tried to understand it better by finding materials such as implementation videos.

Table 2. Categories and Sample Examples concerning to Exploration Theme.

The students stated that after examining the video-based teaching materials before the lesson, they did research about the subjects on which they could not fully understand. And they did research to obtain additional information.

Category	*Frequency*	*Sample expressions (S: Student)*
I have made progress	4	S1: PBFC process made the lesson enjoyable for me. I think I have made quite a bit of progress. Because I felt like I had listened to the lesson more than once and I completed my shortcomings in the lesson. Also, the lesson has become more permanent for me. I realized that I added a lot of information to my existing knowledge. The subjects started to sound easy and fluent for me. It even allowed me to create projects related to computer networks in other courses. Since it helped me master the subject of computer networks, I made projects related to it. S3: PBFC process absolutely provided me improvements. Some topics and questions wouldn't be in our minds if it wasn't for video-based topics. Even if the solutions to some questions do not come to my mind immediately, I can watch the videos again and get the answers to the questions.

Table 3. Categories and Sample Examples concerning to Integration Theme.

Regarding the integration sub-theme, all the students stated that they made progress when they considered the learning process from the beginning.

Category	*Frequency*	*Sample expressions (S: Student)*
I will use it for teaching	3	S2: Since we aim to acquire a profession in Information Technologies Teaching, the information we have learned and will learn in this course will definitely be useful to us. I will use it to teach students the right information in this area.
I will use it for problem solving	3	S4: Of course, I think that I have acquired useful information that I can use in some problems I may experience in my future life and I believe that I can use this information to solve problems.
I will use method	1	S4: As an informatics teacher candidate, I am thinking of providing my students with problem-solving skills by presenting such problem situations.

Table 4. Categories and Sample Examples concerning to Resolution Theme.

All of the students think that they can use the information they have acquired in the course in their future lives. They stated that they will mainly use the information they have acquired for *"educational purposes"* and *"to solve the problems they encounter with computer networks"*. One student stated that he would use the method he encountered in this course in his lessons when he became a teacher.

Findings related to social presence

Regarding social presence, analyses were carried out within the framework of *Emotional Expression*, *Open Communication*, and *Group Cohesion* themes and, the relevant categories were determined. The categories for each theme, how many students responded to these categories, and sample expressions are presented in the tables below.

Category	*Frequency*	*Sample expressions (S: Student)*
Contribution of group work to learning desire	4	S1: There was a desire to learn the lesson content in a more exciting way because I had the opportunity to understand the lesson and ask questions to my friends with the thought of union makes strength. I wanted to participate in the lesson more enthusiastically. The environment encouraged me to participate more actively in the lesson. S4: By sharing our information even if it was wrong, it enabled us to tell and correct the mistakes that we know as correct without hesitation. So it kind of made us want to improve ourselves.
Positive contribution of the instructor's guidance	3	S1: With the guidance of our lecturer, we had the opportunity to learn more accurately the subjects related to the lesson. The lesson made me more eager to attend. S3: In this process, our lecturer directs us and creates a faster and more effective course scope.

Table 5. Categories and Sample Examples concerning to Emotional Expression Theme.

Within the scope of the emotional expression sub-theme, students mostly used expressions about "*Contribution of group work to learning desire*" based on the communication process with their friends while solving problem situations. In addition, students used expressions reflecting that the instructor's guidance made the learning process more efficient and the satisfaction with it.

Category	*Frequency*	*Sample expressions (S: Student)*
Respectful communication	4	S2: Our communication both with our friends and with our teacher was very level and respectful. S4: Our way of mutual respect, love, and address was at a certain level.
Lecturer's instructions	3	S1: The guidance of our lecturer by asking us made us understand the subjects correctly. It was fine for our lecturer to explain the lesson to us with empathy and to explain our comments with the right words. Our lecturer's empathy towards comments and explanations made us love the lesson more.

Table 6. Categories and Sample Examples concerning to Open Communication Theme.

Within the scope of the open communication sub-theme, they mentioned that there is *respectful communication* with the lecturer and other students within the scope of the course content. In addition, they talked about the lecturer's guiding role and the communication that takes place in this context.

Category	*Frequency*	*Sample expressions (S: Student)*
I was a member of the group	4	S2: In the process of solving a given problem, we can act with the awareness of group work. I consider myself a member of the group because of our communication in the group and the respect we show each other. S4: Some of the reasons why I feel like I am a member of the group is that I see that some friends in the group strengthen the information I have gained through my researches.

Table 7. Categories and Sample Examples concerning to Group Cohesion Theme.

Under the sub-theme of group cohesion, all students stated that they felt like a member of a group.

Findings related to teaching presence

Regarding teaching presence, analyses were carried out within the framework of *"Instructional Management"*, "*Building Understanding"* and *"Direct Instruction"* themes, and the relevant categories were determined. The categories for each theme, how many students responded to these categories, and sample expressions are presented in the tables below.

Category	*Frequency*	*Sample expressions (S: Student)*
Topics were designed to suit the level	3	S1: The topics we cover every week are not too much or too little. The weekly lecture topics were not too much to tire us more than necessary. The planning of the instructional process was in such a way that it would not force us to pass the lesson.
Deepening the meaning of problem situations	4	S3: In this process, by planning the design of a problem solving within the group, the method of solving the problem is more effective. S4: In terms of gaining the ability to solve the problem, I find it very useful for us to identify the problems we may encounter in the future.
Request for more implementation possibilities	1	S2: I think there is a need for a little more practice on some of the topics of this course. Of course, I am aware that the facilities of our faculty are also important in this. For example, the permanence of what has been learned can be increased by practicing implementations on subjects such as network topologies.

Table 8. Categories and Sample Examples concerning to Instructional Management Theme.

Within the scope of the instructional management sub-theme, the students talked about the *deepening of the meaning of the problem situations*, and the *design of the subjects according to the level*, respectively. One student mentioned the necessity of having *more implementation possibilities.*

Category	*Frequency*	*Sample expressions (S: Student)*
Guide role	3	S2: Our teacher is guiding us in establishing the relationship of a subject with another subject. Learning will not take place in the absence of this guidance.
Activating the students	3	S4: The lecturer for this course was our resource provider. Our lecturer would leave us alone with the problem to enable us to cope with the problems we may experience today in our own way.
Instructive role	3	S1: Our lecturer has concretized the lesson subjects by giving concrete examples of the lesson subjects that are formed abstractly in our minds. Our lecturer did his best to make the lessons permanent. The necessary methods and techniques used by our lecturer. S3: The lecturer embodies abstract concepts so that we can learn with the support of our lecturer.

Table 9. Categories and Sample Examples concerning to Building Understanding Theme.

Within the scope of the sub-theme of building understanding, students talked about the *guide role* of the lecturer, *activating the students,* and *the instructive role* of the lecturer with similar rates.

Category	*Frequency*	*Sample expressions (S: Student)*
Fluent and plain language usage	4	S2: The fact that the course contents are presented in a language we can understand has increased our interest in the lesson and enabled us to learn the subjects of the lesson more comfortably. S3: An understandable language was used in this lesson
Provide motivation	2	S1: Our lecturer informed us about how to use the lesson in daily life.
Lack of sample	1	S4: More examples should have been given on the subject.

Table 10. Categories and Sample Examples concerning to Direct Instruction Theme.

Within the scope of the direct instruction sub-theme, students talked about the use of fluent and plain language in the presentation of the course content and the motivational role of the lecturer. One student expressed that the process could be better if more examples were given on the subject.

Findings related to learning presence

Regarding learning presence, analyses were carried out within the framework of Self-efficacy, Motivation, and Change in study habits themes, and the relevant categories were determined. The categories for each theme, how many students responded to these categories, and sample expressions are presented in the tables below.

Category	*Frequency*	*Sample expressions (S: Student)*
Increase in self-efficacy	4	S3: There has been a positive change in self-efficacy towards this lesson. S4: Of course, there was an improvement on the individual side, for example, we were able to recognize some practical problems, and then we learned practical activities on how to deal with these problems.

Table 11. Categories and Sample Examples concerning to Self Efficacy Theme.

Within the scope of the self-efficacy sub-theme, all of the students mentioned an increase in their self-efficacy related to the subject.

Category	*Frequency*	*Sample expressions (S: Student)*
Enjoying the course	2	S1: The lesson was not boring. Therefore, I can say that my willingness to study has increased and I have followed the lesson with pleasure. I think it positively affected my desire to study.
Making motivation externally sustainable	2	S2: As my interest in the course and my desire to learn increased, my desire to study in this course increased at the same rate. The main reasons for me to feel in this way are the way the lesson is taught, the approach of our lecturer, the motivation of the lesson, the training videos prepared by the lecturer himself, and the accessible materials whenever needed, easily understandable language, etc.
Intrinsic motivation	2	S4: Since the content of the course is geared towards our field and also for our own personal development, we cared about the topics of our lesson and did research.

Table 12. Categories and Sample Examples concerning to Motivation Theme.

Within the scope of the motivation sub-theme, students talked about enjoying the lesson, making motivation externally sustainable and intrinsic motivation, at similar rates with each other.

Category	*Frequency*	*Sample expressions (S: Student)*
Learning from video-based materials	2	S4: Preliminary information that we gained through videos before the lesson provided new study habits.
Getting ready for class regularly	2	S1: I watched the videos our teacher sent for the lesson repeatedly. I did research at some points. I tried to be prepared for the lesson and tried to give the most accurate answer to the questions our lecturer sent us. I tried to participate actively and understand the lesson. I made preparations with the thought of how I could get efficiency from the course
Studying by taking notes	1	S3: There has been an effective change in our study habits in general. After watching the videos, we got into the habit of taking notes.
Research habit	1	S4: Our lecturer directed us to make researches on the subject from different sources on the internet and directed us to researches to see possible examples of problems related to the subject.

Table 13. Categories and Sample Examples concerning to Change in study habits Theme.

Regarding the sub-theme of change in study habits, the students made statements that could be expressed as *learning from video-based materials*, *getting ready for class regularly*, *studying by taking notes*, and gaining *research habits*.

DISCUSSION

In this study, the CN&C course, conducted using the PBFC model, was conceptually evaluated concerning to the CoI model. Questions regarding *Cognitive presence*, *Social presence*, *Teaching presence*, and *Learning presence* were asked to the students participating in the instruction process. The answers collected were evaluated by dividing them into themes and categories.

Discussion on cognitive presence

Triggering Event, Exploration, Integration, and Resolution themes were obtained within the scope of cognitive presence. Within the scope of the *Triggering Event theme,* all of the students used expressions that video-based contents initiate pre-lesson learning activities. This was followed by the statements that the instructional videos used were re-examined when necessary and offered an opportunity to learn the whole course content. There were also related statements regarding the contributions of video-based materials in terms of developing a positive attitude to the lesson and being active during the lesson. Similar research results regarding the videos used in the FC process have been reached in the literature. Xiu, Moore, Thompson & French (2019) reported a positive attitude in the way that students can stop and take notes, watch videos by dividing them into sections, and access video-based teaching whenever they want. Fung (2020) stated that the videos presented before the lesson provide students with the knowledge and skills they may need as a prerequisite, thus preparing the ground for practice and discussions during the lesson. The videos used in this study are limited to 5-10 minutes. As a result of the short duration of the videos, it is thought that students develop a positive attitude towards the videos. Because in the literature, it is recommended that videos should not be kept too long to help students learn better (Bergmann & Sams, 2012; Akçayır & Akçayır, 2018; Qiang, 2019)

Within the scope of the *Exploration theme*, the students stated that they did research to find out what they could not understand enough from the video-based instruction material and to obtain additional information. This research was conducted with a small group of four. Conducting the FC process with you in a small class provides convenience at the point of communication (McLean & Attardi, 2018) and teachers can provide more help and explanations thanks to one-to-one communication (Bedi, 2018). As a result of this, it is thought that passive learning tendencies (Hao, 2016), which are the main reason for preparedness for the FC process, have been eliminated, and that students can be activated and tend to do research.

Within the scope of the *Integration theme*, all students think that they have made progress regarding the content of the course. When the expressions related to this were examined, it was seen that the students mostly stated that they reviewed the instructional videos

repeatedly and thus they made the meaning of the content properly. In the literature, it is seen that at the end of the FC process, students make cognitive improvements (Jang & Kim, 2020; Cheng, Ritzhaupt & Antonenko, 2019; Zheng, Bhagat, Zhen & Zhang, 2020) and have a depth of meaning (Yoon, Kim & Kang, 2020). This supports the idea of making improvements in course content.

Within the scope of the *Resolution theme*, the students consistently reflected the belief that they could use the information they acquired in their future lives. Looking at the expressions they made, they stated that they can use the knowledge they have acquired to teach other people and to solve network problems they will encounter in daily life. A student stated that he could use the FC method in the future. Participants are Information Technologies teacher candidates. After graduation, they can work as an Information Technology teacher or work in the information technology sector. The opinions of the participants within the scope of the resolution theme are that they can use their learning content in their professional life. In the literature, it is stated that students have acquired gains such as knowledge deepening at the end of the FC process (Alcaraz, Martínez-Rodrigo, Zangróniz & Rieta, 2019; Yoon, Kim & Kang, 2020), gaining contextual self-confidence (Jang & Kim, 2020), making progress for practical events (Aguilar, Santana, Larrañeta & Cuevas, 2020), improving their problem-solving ability (Lin, 2019). Within the scope of the resolution theme, the idea that students can use the information they have acquired in their professional lives overlaps with the literature.

Discussion on social presence

Emotional Expression, Open Communication and *Group Cohesion* themes were obtained within the scope of social presence. Within the scope of the *Emotional Expression theme*, the students stated that the PBL activities they carried out as a group contributed to the formation of the desire to learn, and the instructor's guidance increased the efficiency of the process. The emotional states of the students within the scope of social presence were realized in the focus of motivation and positive thoughts about the efficiency of the process. In the literature, it is stated that the emotional outcomes of the students during the FC process are quite positive (Jang & Kim, 2020). With FC activities, the engagement of students in class increases (Su & Chen, 2018), and perhaps as a result of this, positive contributions can be obtained to their satisfaction level in the course (Fisher, Perényi & Birdthistle, 2018; Martínez-Jiménez & Ruiz-Jiménez, 2020). Based on this result, it can be concluded that the communication process that takes place in the social environment creates positive feelings in the students.

Regarding the *Open Communication theme*, the students have revealed that they are conducting a respectful communication process both among themselves and with the instructor. In addition, they reflected that their communication with the instructor was mainly focused on the questions asked about the content of the video-based teaching

material. In Lecture-based courses, most students want to interact more with the teacher (McLean & Attardi, 2018). By providing more class time for teacher-student communication in the FC process (Bedi, 2018), this requirement can be reduced. In the FC process, communication with the smaller class can be much easier (McLean & Attardi, 2018), and students can socialize among themselves and increase teacher-student communication with group studies conducted within the scope of PBL activities (Cukurbasi & Kiyici, 2018). This research was conducted with a small group. The teaching process was carried out by integrating FC and PBL. As stated in the literature, under these conditions, these results regarding open communication seem quite reasonable. By the way, a recommendation can be made. Future studies can be conducted by the use of the PBFC model with larger groups through a quantitative approach.

Within the scope of the *Group Cohesion theme*, all students used expressions reflecting that they felt like a member of the group. The group in which the study was conducted has been taking the same courses for three years and getting to know each other. In this result, it is thought that besides the opportunity of exchanging ideas provided by the applied method, the students' getting to know each other and having the course in a class consisting of a small number of people have an effect.

Discussion on teaching presence

Instructional Management, Building Understanding, and Direct Instruction categories were obtained within the scope of teaching presence. Within the scope of the *Instructional Management theme*, the students mentioned that the problem-solving activities carried out in the face-to-face instruction environment deepened the meaning, were suitable for the levels of the weekly designed topics, and the subjects complemented each other. In addition, there is a need for students to practice more. The role of the teacher changes in the FC process (McLean & Attardi, 2018; Wei, Cheng, Chen, Yang, Liu, Dong & Zhai, 2020). In this process, which is carried out by integrating with PBL and with the active participation of students, students are aware of the teacher's role in creating a learning environment and guiding them. However, they also stated that they expected of having the practice done with the direct intervention of the teacher.

Regarding the theme of *Building Understanding*, the participants mentioned that the teacher made an effort to concretize abstract concepts, took the role of a guide by preparing an environment for their individual learning, and enabled students to take their own learning responsibilities by activating them. The purpose of using FC by integrating it with methods such as PBL is to make students active (Konijn, Essink, Buning & Zweekhorst, 2018). Thus, the effectiveness of the process can be increased (Chis, Moldovan, Murphy, Pathak & Muntean, 2018). The thoughts emerging within the scope of this theme are an indication that the idea of integrating FC and PBL is appropriate.

Within the scope of the *Direct Instruction theme*, the students mentioned that fluent and plain language was used in the video-based instruction materials, and their motivation for the lesson remained alive by clearly demonstrating when and where the learning content would be useful. The insufficient number of examples in the video-based instruction materials presented is a deficiency within the scope of this theme. If technology is used effectively in the FC process, it can contribute positively to motivation (Lin, 2019). If interactive and active learning methods such as PBL are used in the process, there may be an increase in learning motivation (Cukurbasi & Kiyici, 2018). Based on the expressions reflected by the students within the scope of this theme, it can be interpreted that video-based instruction materials and PBL activities performed in a face-to-face environment are successful in providing motivation.

Discussion on learning presence

Self efficacy, Motivation and Change in study habits themes were obtained within the scope of learning presence. Within the scope of the *self-efficacy theme*, all students stated that there was an increase in their self-efficacy in terms of the course content. Students think that the increase in self-efficacy occurs with the contribution of video-based instruction materials and in-class PBL activities. In the literature, it is stated that the most important variable for perceived impact on learning in the FC process is self-efficacy (Mohamed & Lamia, 2018) and the FC process provides positive change at the point of self-efficacy (Thai, De Wever & Valcke, 2020). As a result of this research, the thoughts put forward by the students for the increase of self-efficacy are parallel to the literature.

Within the scope of the *motivation theme*, the participants stated that their interest remained alive because they enjoyed the lesson, as well as being motivated externally as a result of the role of the lecturer, that they regularly worked. They also added that they did research to learn the course content and that their intrinsic motivation was effective in this. In the literature, it is stated that the FC process contributes positively to student motivation (Su & Chen, 2018; Qiang, 2019; Zheng, Bhagat, Zhen & Zhang, 2020; Jang & Kim, 2020), and as a reflection of this, students are more eager to attend classes (Aguilar, Santana, Larrañeta & Cuevas, 2020). In addition, it is stated that there is an increase in learning motivation as a result of integrating the FC process with interactive and active learning methods such as PBL (Cukurbasi & Kiyici, 2018). Students' opinions about motivation to learn within the scope of this research also support these situations.

Within the scope of the *Change in study habits theme*, the participants mentioned that they gained the habit of learning mainly from video-based instruction materials and that they gained the habit of studying regularly within this course. This is followed by the habit of studying by taking notes and doing research to obtain information from different sources. It is stated in the literature that some students may have difficulty in adapting to the FC process due to passive learning habits (Chen, Wang, & Chen, 2014; Espada, Navia,

Rocu & Gómez-López, 2020). To overcome this, it is recommended that faculty members leave their traditional roles and plan activities to increase cooperation (Martínez-Jiménez & Ruiz-Jiménez, 2020). At the end of this research, data was obtained that the students got out of passive learning habits. It is thought that the possible reason for this is the low number of students and the fact that the process is carried out in an integrated manner with PBL.

CONCLUSIONS

In this study, the PBFC instruction process was executed. During the four-week instruction process, the five-step implementation model was applied (see Figure 1). To evaluate the effectiveness of the process qualitative data was obtained regarding cognitive, social, teaching, and learning presences. The participants talked about the fact that video-based materials started the process within the scope of *cognitive presence*, they did research to obtain additional information, they made progress in the course content, and that they could use what they learned in their future lives. Within the scope of *social presence*, they talked about the contribution of PBL activities to motivation and a respectful communication environment. Within the scope of *teaching presence*, participants mentioned the fact that PBL activities deepen the meaning of the subject, the guide role of the teacher, and the comprehensibility of the video-based teaching materials. Within the scope of *learning presence*, participants talked about the increase in their self-efficacy regarding course content, the formation of regular study habits thanks to video-based materials, and they stated the fact that their intrinsic and extrinsic motivations stayed alive. The results of this study are very positive.

LIMITATIONS

This research is limited to PBFC activities conducted for four weeks. In this context, the students created a solution to four problem situations by doing group work. A total of 13 video-based instruction materials were shared with the participants via WhatsApp. Necessary studies were carried out with the active participation of four people in total and qualitative data were obtained. The results of this short-term study with a small group are very encouraging. The biggest reason for this may be that the communication was facilitated as a result of the instructor's involvement in the process as if he was a part of the group. In the future research, different results may be obtained if the researchers work with large groups for a longer period.

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List of Abbreviations

CEIT: Computer Education and Information Technology department; CoI: Community of Inquiry; CoHE: Turkish Council of Higher Education; CN&C: Computer Networks and Communications course; FC: Flipped classroom; IBL: Inquiry Based Learning; ICT Information and Communication Technology; PBL: Problem Based Learning; PBFC: Problem Based Flipped Classroom.

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APPENDIX: PBFC Interview Questions

Cognitive presence: Could you give information about your interaction with the instruction content within the scope of this course?
Social presence: How do you find the communication process with your group mates as part of this lesson?
Teaching presence: What do you think about the role of the instructor in this course?
Learning presence: Could you explain your individual learning process within the scope of this course?

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Impact of a Faculty Development Strategy Aiming at Mitigating Erosions in a PBL-Based Medical School

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ABSTRACT

Problem-based learning (PBL) is an instructional method that can show erosions and failures throughout its implementation. Faculty development programs reinforcing PBL principles are essential to keep tutorial groups functioning properly. Quasi-experimental study carried out in a medical school, with a PBL curriculum. The institution has launched a faculty development program to improve tutorial performance. The program was based on the dissemination of educational material addressing five perceived erosions in tutorial groups previously identified by the tutors. Students and tutors answered a questionnaire measuring their perception on tutors' performance, before and after faculty development. The overall mean scores of tutors' performance has significantly increased among students when comparing pre- and post-program scores (0.19 + 0.06; p < 0.001). The study has shown that, based on students' perspective, a faculty development program focusing on the remediation of erosions identified by the tutors can help improve tutors' performance in different domains.

Keywords: PBL - Problem-based learning, medical education, faculty development

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INTRODUCTION

The implementation of problem-based learning (PBL) at McMaster University in Canada, in 1969, was one of the main innovations in medical education (Bodagh et al., 2017) in the past 50 years and many medical schools worldwide adopted this instructional method since then.

PBL lies on discussing problem-situations or clinical cases in small groups, also known as tutorial groups (Bodagh et al., 2017). Although the way of conducting PBL sessions can vary among different schools, PBL principles are well-defined and must be respected, namely: activation of prior knowledge, cognitive elaboration, information structuring and restructuring, fostering intrinsic motivation and active and cooperative learning (Moust et al., 2005). PBL has been shown to be highly effective, but it is far from perfect (Hung et al., 2019). Erosions and failures can happen (Dolmans et al., 2005) leading to educational deterioration if left unmitigated (Azer et al., 2013). Medical schools must provide continuous training to teachers/tutors, as well as to find strategies capable of ensuring PBL principles (Moust et al., 2005) among faculty to prevent erosions from happening. Faculty development is defined as a wide range of activities used by institutions to help faculty members to improve their work performance. Given the new educational trends in teaching and assessment, most medical schools and educational organizations need to offer programs and activities to help faculty members improve their skills as educators (Steinert et al., 2016). Although many studies focus on describing interventions aimed at faculty development, few of them assess their effectiveness (Hewson et al., 2000; Steinert et al., 2016).

Azer (2005) has listed 12 "tips" for the successful implementation of tutorial groups in a PBL-based course, most of them focusing on what "not to do": not criticizing; not labeling students; not adopting attitudes that can lead to distortions; not being late; not dominating group discussion; not being an information provider. A Medical School in Brazil, which has a PBL-based curriculum, has developed a faculty development program called "Wise choices in education". This program was inspired in Azer's (2005) recommendations for tutorial groups and aimed at strengthening the PBL principles in the institution. A workshop was conducted with tutors to identify the main perceived erosions on tutorial sessions in their current practice. An educational campaign, including educational banners and electronic messages, was then implemented at medical school to publicize good tutorial practices, focused on the workshop results, to students and teachers.

A questionnaire was designed to assess tutors' performance related to the PBL principles covered in the educational campaign. Students and tutors responded to the questionnaire, before and after the educational campaign.

The main hypothesis of our study was that both students and tutors' perception about tutors' performance would increase after the educational campaign.

MATERIALS AND METHODS

Study design

Quasi-experimental study focused on comparing the perception about tutors' performance among tutors and students, before and after an institutional educational intervention. The study was divided into 5 phases: (1) Identification, by tutors, of perceived erosions in the tutorial groups; (2) Development of a questionnaire based on these erosions; (3) Baseline assessment of the tutors' performance by tutors and students using the questionnaire (4) Educational intervention; (5) Reassessment of tutors' performance after the educational intervention.

The comparison between tutors´ performance scores before and after the educational campaign was used to measure its effectiveness.

Scenarios and participants

The study was carried out at a medical school in Brazil, from February to December 2018. The school has a PBL-based curriculum with tutorial groups as the main educational strategy from the 1st to the 8th semesters.

All students and tutors from the 1st to the 8th semesters at this medical school were invited to participate in the study.

Ethical approval for the study was given by University's ethics committee. The study was carried out in accordance with the Declaration of Helsinki.

Materials and procedures

Phase 1 – Initial workshop

Phase 1 was conducted in February 2018. All 57 tutors were invited to participate in the faculty development program called "Wise choices in education" conducted by medical education specialists from the Center for Studies and Development in Medical Education at the same institution. The workshop started with the presentation of a literature review on PBL erosions to remind the tutors of the main PBL educational principles. In the workshop it was highlighted that tutors' actions that were not aligned with the best practices proposed for PBL curricula might impair students´ learning. Afterwards, the tutors, in small groups, were asked to identify practices that, despite being contrary to

PBL's principles, occasionally happened at the institution. These practices were called "critical points" to be avoided.

At the end of the session, the critical points identified by the groups were shown to all participants and similar items were merged, resulting in 20 critical points associated with undesirable practices. In the following weeks, all tutors in the school, including the ones who did not attend the workshop, were asked to rank the 5 most relevant critical points from the initial 20 items. The five top ranked items were transformed into "do not" advices: (1) do not skip the activation of prior knowledge, (2) do not allow the mechanical reading of information, (3) do not forget to provide good feedback, (4) do not fear to acknowledge your own knowledge gaps, (5) do not allow the resolution map to be a non-contextualized summary of the entire subject.

Phase 2 – Development of the study questionnaire

A specific questionnaire was developed for the study due to lack of a validated instrument in the literature capable of assessing the critical points identified by the initial workshop. The initial step lied on decomposing each of the 5 critical points into questions in order to assess them based on a five-point Likert scale (1- never; 2- almost never; 3 - intermediate frequency; 4- almost always; 5- always). For example, the item "do not skip the activation of students' prior knowledge" was broken into questions such as *"how often does your tutor encourage 'brainstorming'?"* and *"how often does your tutor provide clues to activate your prior knowledge during the analysis session?"* Next, to ensure that each block of questions could reliably represent the item it was expected to assess, three PBL experts reviewed the questionnaire. These PBL experts were teachers at the institution and members of the Center for Studies and Development in Medical Education that is responsible for faculty development. All of them had more than 10 years of experience in tutoring in a PBL curriculum and in conducting tutor development programs.

Two versions of the questionnaires were developed with few adaptations to the items to make them suitable for both students (e.g., *how often does your tutor provide feedback?*) and tutors (e.g., *how often do you provide feedback?*). Face validity was established by a small group of 8 students and 1 tutor that helped to identify any differences in the interpretation of the items. This process allowed semantic adjustments before the pilot study was carried out with a group of 20 individuals, including students and tutors.

Cronbach's alpha coefficient was calculated in the pilot study to assess the reliability (internal consistency) of the set of questions covering each of the five domains. Items presenting Cronbach's alpha coefficient lower than 0.60 in the pilot test were excluded from the study; thus, the final version of the questionnaire comprised 30 items -

approximately six items for each of the evaluated domains (APPENDICES A and B). Cronbach's alpha coefficient was also calculated for data collected in phase 3.

Phase 3 – Baseline assessment

A baseline questionnaire was applied to students and tutors from the 1st to the 8th semesters of the Medical School, in June 2018. The aim of this phase was to have a baseline assessment of the quality of tutors' performance before the educational campaign, based on students and tutors' viewpoint.

Phase 4 – Educational intervention

The institution released the list with the five most relevant critical points selected by the tutors. The PBL educational campaign – supported by the institution's marketing department - was launched in September 2018, when these five items were disclosed in banners and institutional social networks to all students and tutors of the medical school. Posters and banners emphasizing the importance of each critical point were attached to walls in tutorial classrooms and in the hallways of the institution. For example: a banner said "do not skip the activation of prior knowledge", which was followed by a brief description of the pedagogical principle that makes it an important PBL point*: "Students tend to think that they do not have relevant prior knowledge to build an initial explanation of the problem. In addition, by omitting an in-depth analysis of the problem based on their prior knowledge, students do not elaborate, which affects the restructuring of current knowledge and the acquisition of new information".*

In addition, electronic messages, similar to the printed ones, were sent through text messaging Apps to tutors once a week throughout the campaign.

Phase 5 – Post-intervention assessment

Students and tutors from the 1st to the 8th semester answered the same pre-intervention questionnaire 12 weeks after the educational campaign.

Statistical analysis

A comparative analysis of participants' mean perception about tutors´ performance before and after the educational campaign was carried out based on repeated-measures ANOVA test. The analysis was stratified by participant category (students vs. tutors) and by course stage (1-4th semester vs. 5th to 8th semester), and was conducted for each one of the evaluated domain. As each educational domain was composed of different items, domain scores were calculated as the average score of such items. All results were considered significant at probability level lower than 5% ($p < 0.05$).

RESULTS

Fifty-six percent (56%) of the 57 tutors participated in the workshop conducted in phase one of this study, 56% of them ranked the top-five critical points in phase 2 and 100% of them participated in phases 3 and 5.

There was a higher proportion of female tutors in phases 3 and 5 - 69.6% and 71.8% respectively, reflecting the composition of the institution's faculty. The median age of the tutors was 42 years (IQR: 36-49 years) in phase 3 and 43 years (IQR: 37-49 years) in phase 5. Median tutoring time of teachers in both phases was 8 semesters (IQR: 3-16 semesters in phase 3; 4-16 semesters) in phase 5.

In total, 564 students participated in the pre-assessment of the educational intervention: 204 students from the 1st to the 4th semester and 260 from the 5th to the 8th semester. On the other hand, 603 students participated in the post-assessment phase of the study: 346 students from the 1st to the 4th and 257 from the 5th to the 8th semester. Student participation represented approximately 88% of the target population (students enrolled from the 1st to the 8th semesters). The proportion of female students was higher in both phases of the study - 64.2%, in phase 3 and 62.7%, in phase 5 - and it reflected the composition of the institution's medical students. The median age of students was 22 years old (IQR: 20-24 years) in phase 3, and 21 years old (IQR: 20-23 years) in phase 5. Students' minimum age was 17 years old and their maximum age was 60 years old.

The internal consistency of the questionnaire was assessed through Cronbach's alpha coefficient based on the total questionnaire and after removal of each individual question. Cronbach's alpha coefficient estimated for the total questionnaire was 0.60 among tutors and 0.77 among students (APPENDIX C – SUPPLEMENTARY MATERIAL).

Global mean scores of tutors' performance pre- and post- intervention were compared to assess its effectiveness. Mean scores post-intervention were higher than those pre-intervention for both tutors (4.24 + 0.15 vs. 4.15 + 0.33; $p = 0.15$) and students (4.03 ± 0.48 vs. 3.84 ± 0.50; $p < 0.001$), although it was statistically significant only among the latter (Table 1).

The analysis stratified by educational domain did not show significant differences between study phases in any of the 5 domains analyzed among tutors (Table 1). The group of students has shown significant difference between study phases in all evaluated domains with significantly higher mean scores post-intervention (Table 1). Effect size (Cohen´s *d*) per domain ranged from 0.2 to 0.5 among students (Table.1).

The global mean pre-intervention scores for tutors' self-perceived performance was higher than that of students (range 1-5, mean=4.15 ± 0.33 vs. 3.84 ± 0.50, respectively; p

< 0.001). A separate analyses of each of the 5 domains showed higher mean scores among tutors when compared to students ($p < 0.05$) in each of the domains (APPENDIX C – SUPPLEMENTARY MATERIAL).

Based on the analysis stratified per domain, tutors continued to show higher scores for four of the five evaluated domains after the educational campaign (phase 5). Domain "*do not allow the resolution map to be a non-contextualized summary of the entire subject*" was the only one that did not show a significant difference between students and tutors after the intervention (APPENDIX C – SUPPLEMENTARY MATERIAL).

Post-intervention mean scores for tutors' performance was higher for tutors than for students (4.24 ± 0.39 vs. 4.03 ± 0.48, respectively; $p < 0.001$) (APPENDIX C – SUPPLEMENTARY MATERIAL).

Comparison between mean scores for each of the 5 investigated domains of students from the 1st to the 4th (n = 204) and students from the 5th to the 8th semester (n = 260) in phase 3 showed significant differences in the following domains: "mechanical reading of information"; "feedback"; and "fear to acknowledge own knowledge gaps" - the highest means were recorded for students from 1th to 4th semester (Table 2). Scores from tutors from 1-4th vs. 5-8th semesters did not significantly differ in any of the five domains.

As shown in Table 3, the group of students from 1th to 4th semester (n = 346) presented significantly higher post-intervention means for the following domains than students from 5th to 8th semester (n = 257): "mechanical reading of information" and "feedback". Comparing scores from tutors from 1-4 th (n = 39) vs. 5-8th semesters (n = 31) tutors, "feedback" was the only domain with difference in mean scores, with higher scores observed among tutors from 1-4th (Table 4).

Domains	**Students' means (standard deviation)**				**Tutors' means (standard deviation)**		
	Before the campaign	**After the campaign**	**p**	**Cohen's d**	**Before the campaign**	**After the campaign**	**p**
Global	3.84 (0.50)	4.03 (0.48)	< 0.001		4.15 (0.33)	4.24 (0.39)	0.15
Do not skip the activation of prior knowledge	3.92 (0.60)	4.17 (0.59)	< 0.001	0.42	4.35 (0.35)	4.42 (0.43)	0.331
Do not allow the mechanical reading of information	3.67 (0.58)	3.86 (0.60)	< 0.001	0.32	3.87 (0.48)	4.03 (0.47)	0.05
Do not forget to provide good feedback	3.08 (0.95)	3.30 (1.01)	< 0.001	0.22	3.50 (0.67)	3.66 (0.69)	0.188
Do not fear to acknowledge your own knowledge gaps	4.28 (0.69)	4.42 (0.65)	< 0.001	0.21	4.54 (0.45)	4.61 (0.46)	0.443
Do not allow the resolution map to be the summary of 'the entire' subject	4.25 (0.69)	4.42 (0.620	< 0.001	0.26	4.49 (0.60)	4.49 (0.56)	0.997

Table 1. Descriptive and comparative measurements taken, both globally and for each of the 5 domains of interest, between phases - Group: students and tutors.

Domains	course stage (semester)	**Mean (standard deviation)**	**p**
Do not skip the activation of prior knowledge	1st to 4th	3.89 (0.59)	0.29
	5th to 8th	3.95 (0.61)	
Do not allow the mechanical reading of information	1st to 4th	3.75 (0.57)	< 0.001
	5th to 8th	3.58 (0.58)	
Do not forget to provide good feedback	1st to 4th	3.33 (0.92)	< 0.001
	5th to 8th	2.78 (0.90)	
Do not fear to acknowledge your own knowledge gaps	1st to 4th	4.39 (0.63)	< 0.001
	5th to 8th	4.16 (0.72)	
Do not allow the resolution map to be the summary of 'the entire' subject	1st to 4th	4.25 (0.72)	0.99
	5th to 8th	4.25 (0.65)	

Table 2. Analysis per course stage - descriptive and comparative measurements of each of the 5 domains of interest in the group of students - phase 3.

Domains	course stage (semester)	**Mean (standard deviation)**	**p**
Do not skip the activation of prior knowledge	1st to 4th	4.13 (0.56)	0.09
	5th to 8th	4.22 (0.62)	
Do not allow the mechanical reading of information	1st to 4th	3.92 (0.59)	0.004
	5th to 8th	3.78 (0.60)	
Do not forget to provide good feedback	1st to 4th	3.46 (0.96)	< 0.001
	5th to 8th	3.08 (1.03)	
Do not fear to acknowledge your own knowledge gaps	1st to 4th	4.46 (0.65)	0.09
	5th to 8th	4.35 (0.65)	
Do not allow the resolution map to be the summary of 'the entire' subject	1st to 4th	4.43 (0.63)	0.53
	5th to 8th	4.40 (0.61)	

Table 3. Analysis per course stage - descriptive and comparative measures of each of the 5 domains of interest in the group of students - phase 5.

Domains	course stage (semestrer)	**Mean (standard deviation)**	**p**
Do not skip the activation of prior knowledge	1st to 4th	4.47 (0.35)	0.24
	5th to 8th	4.34 (0.51)	
Do not allow the mechanical reading of information	1st to 4th	4.08 (0.43)	0.28
	5th to 8th	3.96 (0.51)	
Do not forget to provide good feedback	1st to 4th	3.89 (0.61)	0.001
	5th to 8th	3.36 (0.69)	
Do not fear to acknowledge your own knowledge gaps	1st to 4th	4.63 (0.38)	0.62
	5th to 8th	4.57 (0.54)	
Do not allow the resolution map to be the summary of 'the entire' subject	1st to 4th	4.41 (0.50)	0.27
	5th to 8th	4.56 (0.64)	

Table 4. Analysis per course stage - descriptive and comparative measurements of each of the 5 domains of interest in the group of tutors - phase 5.

DISCUSSION

We aimed to evaluate the effect of a faculty development program called "Wise choices in Education" in the perception of medical students and their tutors about tutors' performance at a medical school. Students and tutors' perceptions were evaluated before and after the intervention. Results have shown that the strategy had a positive impact on students' perception of tutors' performance. This impact was significant but had a small effect size. Tutors rated their own performance better than students, and the faculty development program did not have a significant impact on their self-perception. Students from the 1st to the 4th semester rated their tutors' performance better than students from the 5th to the 8th semester.

Results have shown that the program was successful in revitalizing important aspects of tutorial group functioning that depend on tutors' performance. This result was expected, since the educational initiative was based on perceived erosions on PBL's principles identified in a previous workshop and focused on specific difficulties faced by this faculty group. Educational initiatives based on faculty perceived gaps (bottom-up approach), rather than on what course directors think they need (top-down approach), appear to be crucial for the design of successful interventions aimed at improving PBL functioning (Moust et al., 2005). The campaign also took advantage of experiential learning, bringing attention to good tutorial practices where they occur, while highlighting the theoretical principles underlying the learning processes fostered by PBL, two features that contribute to faculty development (Steinert et al., 2016). The intensive use of a mix of printed and electronic educational resources also appears to have been decisive for the campaign to be successful, as it allowed it to reach all tutors, even those who resist attending centralized faculty development programs - possibly those who need them most (Steinert et al., 2009).

The assessment of the intervention had a wide participation of students (90%), which indicates that most of the academic community, at least to some extent, got involved with the educational campaign. Students' involvement is very important: according to Azer (2005), PBL works best when students, and not only tutors, understand the different factors influencing the learning process. The campaign may have raised students´ awareness of the importance of the tutorial group steps, making them act as practice transformation agents.

The positive effect of the campaign on tutors' performance evaluation was limited to students' perception, with a small effect-size. Nevertheless, the perception of tutors' performance by students is very important and shows how those in the center of the process feel about it. Moreover, students' scores on tutors' performance were already high before the campaign, with overall mean =3,84, which could explain the small effect-size observed.

Systematic reviews conducted by Bilal, Guraya and Chen (2019) and Leslie et al. (2013) showed that faculty development programs can have positive impact in medical education practices, enriching faculty's knowledge and skills. Bilal, Guraya and Chen's review found programs to have effect sizes that ranged from small to large (Bilal et al., 2019). The nature, purposes and outcome measurements of the programs, however, vary a lot, making it difficult to compare them with our intervention. Most interventions are based on workshops, short courses and seminars, and those which assess behavioral change as the outcome measurement usually do it from teachers'/tutors' own perspectives only. Those which assess students' perspective about their tutors' behavior are scarce. Our

findings adds to the literature showing that well-structured faculty development programs in healthcare might be effective from students' point of view.

As expected, the global mean scores recorded for tutors' assessment was significantly higher than that of students' assessment, both before and after the campaign. Hewson, Copeland and Fishleder (2000) have also observed that teachers rated themselves as very competent in all teaching skills before the educational development program. In addition, the difference in perception between tutors and students had already been observed by Zanolli, Boshuizen and Grave (2002). Students appeared to be more "pessimistic" than their tutors about how the method works, likely because of tutors' overestimated view about their own performance and/or of students' underestimated view about how the method works. Tutors' high scores on their own performance before the campaign might also have caused a "ceiling effect", hindering a positive effect of the campaign.

The comparison of evaluations by students enrolled from the 1st to 4th semesters, and by those enrolled from the 5th to 8th semesters, has suggested that tutors' adhesion to good PBL practices decreased in three of the evaluated domains as the course progressed, namely: allowing mechanical reading of information, providing good feedback and acknowledging knowledge gaps. Zanolli, Boshuizen and Grave (2002) have also shown significant differences in several issues found in tutorial groups between second-year students (pre-clinical phase) and third-year students (clinical phase): third-year students had more pessimistic perceptions about feedback issues than second-year students. Based on the authors' perspective, this finding may reflect the fact that the more students are experienced and adapted to the method, the more critical they tend to be towards tutors´ skills.

Based on the analysis of each separate domain, acknowledging knowledge gaps had the highest mean scores among tutors and students, before and after the campaign. Tutors are not responsible for providing all content to students in PBL. In fact, they must play active roles in students' learning process so they can build their own knowledge. Therefore, acknowledging knowledge gaps does not represent a failure in the tutorial group (Chng et al., 2011). On the contrary: tutors' open attitude to admit that they may not know the answer to every question reinforces the need for lifelong learning, as long as tutors commit to remedy the situation (Pazin Filho, 2017). The current study has shown that this adult learning feature appears to be preserved in the medical school where this research was made, both in tutors and students' perspectives. This outcome may be explained by tutors' experience (8 semesters, or 4 years, on average) and by faculty development programs periodically carried out at the investigated school.

On the other hand, providing good feedback recorded the lowest scores both in tutors' self-assessment and in students' assessment, in both assessment times. Ende (1983)

defines feedback in the medical education context as the information describing students' performance in a given activity aimed at guiding their future performance in that very same activity or in a related one. Although feedback is considered a fundamental step in the adult teaching-learning process (Chng et al., 2011), there is evidence that it is often omitted or treated inappropriately (Ramani & Krachov, 2012). It is important emphasizing that the perception about what feedback is can differ between tutors and students: tutors may consider that they give feedback, but students may not perceive it (Branch Jr, & Paranjape, 2002), a fact that may explain the difference in assessment between students and tutors. Finally, feedback scores decreased from pre-clinical to clinical years, which may result from the misperception that PBL-experienced students have less to learn from the feedback provided by their tutors than PBL-beginners. However, these inferences require further investigations.

The current study had some limitations. The first of them is associated with the questionnaire that was elaborated by the authors. Such development was necessary because we could not find in the literature any validated instrument to assess the PBL-erosions identified by the tutors. Indeed, this appears to be a limitation in most studies in this field. Steinert's (2016) review has shown that most studies aimed at analyzing the effectiveness of faculty development programs have also used non-validated questionnaires, which were specifically designed to evaluate a given intervention. It is noteworthy that, although the instrument was not validated, it was developed by PBL experts and had good internal consistency. Finally, although the questionnaire has reliably assessed the herein five selected domains, other aspects of tutorial group dynamics were not addressed. Zanolli, Boshuizen and Grave (2002) have shown that addressing all relevant tutorial group aspects is not an easy task and the current study did not intend to carry out such a comprehensive assessment. A further limitation of the study was the fact that our baseline assessment of tutors´ performance was conducted after an educational workshop that was attended by approximately 50% of the tutors. Therefore, we were not able to assess the effect of this initial step of our educational initiative and to evaluate how it might have contributed to the high baseline scores observed for some of the domains. On the other hand, the workshop before the intervention allowed the awareness of the erosions as perceived by the tutors that carry PBL sessions in the school, at a specific period of time, which is important to the success of interventions, as discussed before (Moust et al., 2005).

CONCLUSION

The current study has shown that, based on students' perception, a faculty development program focused on PBL-erosions identified by the tutors and that used different faculty development strategies, as workshops, banners and electronic messages, can help improving tutors' performance in PBL tutorials. Additional studies should be conducted

to determine how long the positive effect of such program might last, as well as its potential effects on domains other than those covered in the evaluated educational initiative.

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APPENDIX A - Tutorial group assessment questionnaire – students' version

Sex: ( ) M ( ) F age: ____ years current course cycle: ____ period when the student started the course:___

The items below refer to tutors' performance during the tutorial group. Read and mark an X in each item meeting your opinion about your current tutor, based on a scale from 1 to 5, wherein: *1-never; 2-almost never; 3-intermediate frequency; 4-almost always and 5-always*.

	Never	Almost never	Intermediate frequency	Almost always	Always
1. How often does your tutor encourage "brainstorming"?	1	2	3	4	5
2. How often does your tutor provide clues to activate your prior knowledge during the analysis session?	1	2	3	4	5
3. How often does your tutor address students' previous experiences by liking them to the addressed problem?	1	2	3	4	5
4. How often does your tutor merge phases P3 (brainstorming) and P4 (analysis map)?	1	2	3	4	5
5. How often does your tutor "skip" the analysis map development stage?	1	2	3	4	5
6. How often does your tutor recover the analysis map at the beginning of the resolution session?	1	2	3	4	5
7. How often does your tutor allow you to read the studied content directly from the bibliography?	1	2	3	4	5
8. How often does your tutor encourage you to read your summary?	1	2	3	4	5

	Never	Almost never	Intermediate frequency	Almost always	Always
9. How often does your tutor encourage you to explain the problem in your own words?	1	2	3	4	5
10. How often does your tutor encourage you to summarize in your own words what you have learned?	1	2	3	4	5
11. How often does your tutor encourage knowledge application to the problem in question?	1	2	3	4	5
12. How often does your tutor encourage knowledge application to other situations or problems?	1	2	3	4	5
13. How often does your tutor encourage you to understand the concepts and mechanisms of the problem?	1	2	3	4	5
14. How often does your tutor provide feedback on the group's performance at the end of the TG?	1	2	3	4	5
15. How often does your tutor expose the TG's strengths to the group?	1	2	3	4	5
16. How often does your tutor discuss the negative aspects of TG with the group?	1	2	3	4	5
17. How often does your tutor score your participation at the end of the TG session?	1	2	3	4	5

	Never	Almost never	Intermediate	Almost always	Always
18. How often does your tutor provide individual feedback whenever needed?	1	2	3	4	5
19. How often does your tutor finish the TG session without evaluating the group's performance?	1	2	3	4	5
20. How often does your tutor ask the group for feedback on his/her performance during TG?	1	2	3	4	5
21. How often does your tutor confess to the group that he/she does not know a certain concept?	1	2	3	4	5
22. How often does your tutor tell the group that he/she will study to clarify an unresolved doubt raised by the group?	1	2	3	4	5
23. How often does your tutor ignore the doubts raised by the group?	1	2	3	4	5
24. How often does your tutor finish the tutorial group session without clarifying students' doubts?	1	2	3	4	5
25. How often does your tutor return to doubts previously raised by the group or by him/herself for clarification?	1	2	3	4	5
26. How often does your tutor encourage the recovery of the problem during the resolution session?	1	2	3	4	5

	Never	Almost never	Intermediate frequency	Almost always	Always
27. How often does your tutor encourage the application of the discussed content to solve the problem in question?	1	2	3	4	5
28. How often does your tutor ignore the analysis map at the time to build the resolution map?	1	2	3	4	5
29. How often does your tutor encourage the construction of the resolution map applied to the problem?	1	2	3	4	5
30. How often does your tutor ignore the problem in question at the time to build the resolution map?	1	2	3	4	5

APPENDIX B - Tutorial group assessment questionnaire – tutors' version

Sex: ( ) M ( ) F age: __ years cycle: __ Total tutoring time (in semesters): _____

The items below refer to tutors' performance during the tutorial group. Read and mark an X in each item meeting your opinion about your performance in your current group (if you were tutor for more than one period, choose only one of them for your answers). Use the following scale to score your answers: *1-never; 2-almost never; 3-intermediate frequency; 4-almost always and 5-always.*

	Never	Almost never	Intermediate frequency	Almost always	Always
1. How often do you encourage "brainstorming"?	1	2	3	4	5
2. How often do you provide clues to activate students' prior knowledge during the analysis session?	1	2	3	4	5
3. How often do you stimulate students' previous experiences by linking them to the addressed problem?	1	2	3	4	5
4. How often do you merge phases P3 (brainstorming) and P4 (analysis map)?	1	2	3	4	5
5. How often do you "skip" the analysis map development stage?	1	2	3	4	5
6. How often do you recover the analysis map at the beginning of the resolution session?	1	2	3	4	5

	Never	Almost never	Intermediate frequency	Almost always	Always
7. How often do you allow students to read the studied content directly from the bibliography?	1	2	3	4	5
8. How often do you encourage students to read their own summary?	1	2	3	4	5
9. How often do you encourage students to explain the problem in their own words?	1	2	3	4	5
10. How often do you encourage students to summarize what they have learned in their own words?	1	2	3	4	5
11. How often do you encourage knowledge application to the problem in question?	1	2	3	4	5
12. How often do you encourage knowledge application to other situations or problems?	1	2	3	4	5
13. How often do you encourage students to understand the concepts and mechanisms of the problem?	1	2	3	4	5
14. How often do you provide feedback on the group's performance at the end of the tutorial session (TS)?	1	2	3	4	5
15. How often do you expose the TS's strengths to the group?	1	2	3	4	5
16. How often do you discuss the negative aspects of TS with the group?	1	2	3	4	5

	Never	Almost never	Intermediate frequency	Almost always	Always
17. How often do you score the participation of each student at the end of the TS session?	1	2	3	4	5
18. How often do you provide individual feedback whenever needed?	1	2	3	4	5
19. How often do you finish the TS session without evaluating the group's performance?	1	2	3	4	5
20. How often do you ask the group for feedback on your own performance during TS?	1	2	3	4	5
21. How often do you confess to the group that you do not know a certain concept?	1	2	3	4	5
22. How often do you tell the group that you will study to clarify an unresolved doubt raised by them?	1	2	3	4	5
23. How often do you ignore the doubts raised by the group?	1	2	3	4	5
24. How often do you finish the tutorial group session without clarifying students' doubts?	1	2	3	4	5
25. How often do you return to doubts previously raised by the group or by yourself for clarification?	1	2	3	4	5
26. How often do you encourage the recovery of the problem during the resolution session?	1	2	3	4	5
27. How often do you encourage the application of the discussed content to solve the problem in question?	1	2	3	4	5

	Never	Almost never	Intermediate frequency	Almost always	Always
28. How often do you ignore the analysis map at the time to build the resolution map?	1	2	3	4	5
29. How often do you encourage the construction of the resolution map applied to the problem?	1	2	3	4	5
30. How often do you ignore the problem in question at the time to build the resolution map?	1	2	3	4	5

APPENDIX C – Supplementary Material

Question	Cronbach's alpha	Question	Cronbach's alpha	Question	Cronbach's alpha
1	0.60	11	0.51	21	0.61
2	0.58	12	0.56	22	0.62
3	0.55	13	0.57	23	0.63
4	0.61	14	0.59	24	0.62
5	0.60	15	0.57	25	0.59
6	0.61	16	0.58	26	0.59
7	0.64	17	0.57	27	0.57
8	0.59	18	0.60	28	0.65
9	0.57	19	0.64	29	0.59
10	0.55	20	0.58	30	0.64
Full questionnaire					**0.60**

Table 1. Analysis of the internal consistency and reliability of the questionnaire in the tutors' group, based on the removal of each indicated question and on the full questionnaire – phase 3.

Question	**Cronbach's alpha**	**Question**	**Cronbach's alpha**	**Question**	**Cronbach's alpha**
1	0.76	11	0.76	21	0.71
2	0.76	12	0.76	22	0.76
3	0.76	13	0.76	23	0.78
4	0.78	14	0.75	24	0.78
5	0.78	15	0.75	25	0.76
6	0.77	16	0.75	26	0.76
7	0.78	17	0.76	27	0.76
8	0.77	18	0.76	28	0.79
9	0.76	19	0.80	29	0.76
10	0.75	20	0.76	30	0.79
Full questionnaire					**0.77**

Table 2. Analysis of the internal consistency and reliability of the questionnaire in the students' group, based on the removal of each indicated question and on the full questionnaire – phase 3.

Domains	**Group**	**Mean (Standard deviation)**	**p**
Global	students	4.15 (0.33)	0.001
	tutors	3.84 (0.50)	T>A
Do not skip the activation of prior knowledge	students	4.35 0.35)	< 0.001
	tutors	3.92 (0.60)	T > A
Do not allow the mechanical reading of information	students	3.87 (0.48)	0.014
	tutors	3.67 (0.58)	T > A
Do not forget to provide good feedback	students	3.50 (0.67)	0.001
	tutors	3.08 (0.95)	T > A
Do not fear to acknowledge your own knowledge gaps	students	4.54 (0.45)	0.005
	tutors	4.28 (0.69)	T > A
Do not allow the resolution map to be the summary of 'the entire' subject	students	4.49 (0.60)	0.014
	tutors	4.25 (0.69)	T > A

Table 3. Descriptive and comparative measures taken, both globally and for each of the 5 domains of interest, between phases - Group: students and tutors – phase 3.

Domains	**Group**	**Mean (Standard deviation)**	**p**
Global	students	4.24 (0.39)	**< 0.001** T>A
	tutors	4.03 (0.48)	
Do not skip the activation of prior knowledge	students	4.42 (0.43)	**< 0.001** T > A
	tutors	4.17 (0.59)	
Do not allow the mechanical reading of information	students	4.03 (0.47)	**0.020** T > A
	tutors	3.86 (0.60)	
Do not forget to provide good feedback	students	3.66 (0.69)	**0.003** T > A
	tutors	3.30 (1.01)	
Do not fear to acknowledge your own knowledge gaps	students	4.61 (0.46)	**0.019** T > A
	tutors	4.42 (0.65)	
Do not allow the resolution map to be the summary of 'the entire' subject	students	4.49 (0.56)	**0,374** **T = A**
	tutors	4.42 (0.62)	

Table 4. Descriptive and comparative measurements taken, both globally and for each of the 5 domains of interest between students and tutors – phase 5.

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Enculturation of Psychologists through Problem-Based Learning in Aalborg University's Children's Clinic

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ABSTRACT

Problem-based learning (PBL) involves using problems as a starting point of learning rather than relying on traditional learning settings. In the present paper we present the theoretical framework behind a specific PBL setting we have developed since 2012 for training Danish psychologist students in a small university children's clinic (Børnesprogklinikken) at Aalborg University, Denmark. We argue that our approach can serve as students' enculturation into a specific profession, and that concepts from the theory of cultural learning and the concept of mediation can elucidate why this type of learning is effective for human beings, and specifically for students learning a profession. Finally, we discuss some of the learning outcomes of the PBL programme.

Keywords: Psychologist, problem-based learning (PBL), enculturation, children's clinic, mediated learning

INTRODUCTION

It is a well-known challenge for teachers in higher education to prepare students for their future profession. One important question related to this challenge is how to minimize the natural gap between life as a student and life as a professional. Working in professional healthcare services with daily face-to-face interactions involves a high level of responsibility, which again may cause the gap to become particularly large and cause

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anxiety within novice professionals. Danish student psychologists[1] often struggle with personal worries and anxiety about whether they ever will be ready to take on the responsibility linked to being a professional psychologist. In our PBL approach we argue that one means of closing this anxiety-creating gap is through the implementation of problem-based learning (PBL), an approach highly relevant when teaching and learning psychology in higher education (Wiggins et al., 2016).

In Denmark, the academic title 'psychologist' is a protected title and only individuals who hold a university Masters degree (MSc) in psychology are entitled to use the title. Once holding a psychologist degree, it is common to then become an authorized psychologist (Law for Danish psychologists, 2018 [Psykologloven]), The requirements to become an authorized psychologist consist of two years of supervised psychological practice, as part of a full-time paid job. Following this process, psychologists are then able to become specialized within a specific area, indicating a yet higher level of expertise and they are expected to be able to supervise colleagues.

The aim of the current paper is to provide an introduction to the theoretical underpinnings of a particular PBL and practice-based pedagogical setting. We describe and discuss how experiential learning within a specific PBL programme, which consists of a child and adolescent program currently offered at the Aalborg University Clinic for Developmental Communication Disorders (DCD), supports Danish student psychologists towards their *enculturation* as new practitioners, and in learning how to understand concrete psychological concepts and problems within the established practice of Danish psychologists.

THE AALBORG PBL MODEL

In order to understand the setting of our PBL program, we first briefly introduce the general PBL framework of Aalborg University (AAU), Denmark. At AAU, PBL is the cornerstone of all teaching, and approximately half of the teaching consists of longer problem-based project work in groups, followed by group exams, while the other half involves study courses (teaching basic and general skills, competences and knowledge) with individual examinations.

The Danish psychologist education consists of a five-year university degree: the first three years lead to a bachelor degree and the final two years, the "kandidatuddannelse", lead to the professional psychologist Cand.Psych. degree, broadly equivalent to an MSc in psychology.

Although the Cand.Psych. degree is not a specialized degree, each student at Aalborg University must enrol in a specific professional programme ("professionsprogram")

during their final two years, and which accounts for 55 of their total 120 ECTS credits for this period. In addition to the Masters thesis, which is worth 30 credits, students take compulsory introduction courses within applied psychological areas (psychological testing, psychological professionalism, psychological practice and intervention methods), and two topic-based elective courses as well as advanced research methods worth a total of 35 credits.

The courses offered during the 1st semester of the programme at the DCD 'professionsprogram' provide the students with relevant background knowledge concerning theory, practice and intervention for children with language and communication disorders and other neuropsychological disorders (autism, ADHD), and the principles of dynamic assessment (DA) and systemic family therapy.

During the 2nd semester, students enter an internship, where they engage with clients at the clinic, and which is worth 15 credits. Finally, for the 3rd semester, students conduct a problem-based empirical or theoretical project, in which they are required to link theory, method and practice.

PROBLEM-BASED LEARNING: PROS AND CONS

Existing reviews of concrete PBL practices in higher education often reflect the case of students within the disciplines of healthcare sciences such as medicine (Dochy et al., 2003; Prozzer & Sze, 2014; Tudor Car et al., 2019) but also psychology (Wiggins et al., 2016). However, disciplines within humanities or social sciences, and in particular those including professional practices such as addressing neuropsychological disorders have been described to a lesser degree (Prosser & Sze, 2014).

The PBL approach at Aalborg University is comparable to other approaches within the field of PBL in that we use problems as a starting point of learning. It must be student-centred, organised in small groups of students with a guiding or facilitating tutor, and must focus on complex problems (see Illeris, 1981; Barrows, 1986; Kolmos, Fink & Krogh, 2004). Consequently, exams also require students to apply their knowledge to problem-solving situations.

Following the arguments raised by Wiggins et al (2016), psychology - due to its nature as a discipline about human beings, their development, social interactions, thinking, learning etc. - has plenty to offer within the framework of PBL. Characteristics of PBL include the development of students' cognitive and meta-cognitive abilities, motivation, knowledge, problemsolving and collaborating skills (Hmelo-Silver, 2004).

A meta-analysis by Dochy et al. (2003) showed that PBL students are advanced in *applying* their knowledge compared to students in traditional learning settings. These findings were supported in a study within an undergraduate educational psychology course. Here PBL students performed significantly better on the ability to apply theories to real-world settings compared to students in a lecture/discussion condition (Bergstrom et al., 2016). However, PBL settings sometimes also seem to influence the development of students' *knowledge base,* in a negative direction, compared to more traditional learning situations (Dochy et al., 2003).

In relation to transfer of learning between different settings, studies have demonstrated that, if a principle is just taught, transfer is approximately 5% (Quilici & Mayer, 1996 in Norman, 2009), if demonstrated with an example, transfer may be 25%, and finally, if demonstrated with *several* examples, transfer may reach 47% (Catrambone & Holyoak, 1989 in Norman, 2009; Lowenstein et al., 2003 in Norman, 2009). Active problem solving, on the other hand, seems to provide the highest transfer of up to 90% (Needham and Begg, 1991). Moreover, PBL supports students' abilities to develop collaboration and interpersonal skills (Papinczak, Young & Groves, 2007; Rosander & Hammar Chiriac, 2016).

Collaboration implies providing positive as well as negative critique to peers which sometimes may be difficult for students to engage in. In a study with PBL students during their first year in the Swedish psychologists' programme at Linköping University, Rosander & Hammar Chiriac (2016) asked the students in a PBL course to reflect on the purpose of the tutorial groups. The statements roughly fell into two categories, opinions on learning and on social influence. Related to the group's social influence were positive elements such as support, friendships and personal development, but also more negative elements such as feelings of being controlled, and pressures to adjust to group norms and to work hard enough.

The question of peer assessment was addressed by Papinczak et al. (2007) in a PBL study with medical students. In this study the students commented that they find it hard to criticise friends. Providing close colleagues with constructive critique that gives them the opportunity for developing their professional capability is a challenging task for students.

Offering and receiving supervision is an important aspect of qualification within the Danish psychologist profession. In Denmark, most psychologists achieve authorisation from the Danish Psychological Association, which for example implies 160 hours' supervision from experienced psychologists. In the case of the learning setting of our DCD university clinic, we apply the concept of reflective team from systemic family therapy in order to provide a secure and also constructive setting for students to practice the professional skills of providing and receiving supervision.

While the notion of transfer of knowledge is well-addressed in the literature on PBL, the challenge of educating to professional practices within a specific cultural setting, where the students need to construct their emerging identity, as for example, a Danish psychologist, has been less addressed as a cornerstone for their ability to learn. In order to develop this specific type of professional identity, the student needs to engage actively in what is known as the process of *enculturation*.

In the following, we present the theoretical underpinnings of the PBL setting applied in our DCD programme in terms of the process of professional enculturation by means of mediated tutoring, which is nested within the theory of cultural learning, and the principles of mediation applied within dynamic assessment.

PROBLEM-BASED LEARNING AS ENCULTURATED LEARNING

According to the theory of cultural learning developed by the American developmental psychologist Micheal Tomasello, human beings are biologically adapted for culture and hold a unique understanding of other persons as intentional agents like themselves. Human cognitive development and learning must therefore first and foremost be understood in the context of culture (Tomasello, 2000).

We know from developmental psychology that infants are born with an ability to *imitate* others, and this ability gives them access to a unique way of acquiring skills from more competent others. Following imitative learning the more complex learning style, namely learning via verbal *instruction*, which requires the ability to read the mind of the adult or the instructor, emerges later in older children and adults (Callaghan, Moll, Rakoczy, Warneken, Liszkowski, Behne, Tomasello & Collins, 2011).

Collaborative learning, a yet more advanced learning style addressed within the theory of cultural learning, additionally involves peer interaction holding a clear common goal and the opportunity to exchange perspectives (Callaghan et al., 2011). From a phylogenetic perspective, collaborative learning is viewed as the most impressive human cognitive achievement and has resulted in groups working together to create artifacts and practices that accumulate improvements across generations over cultural-historical time, also known as the ratchet effect (Cole & Cagigas, 2010; Tomasello, Kruger & Ratner, 1993; Vygotsky, 1978). This important knowledge from developmental psychology underlines the collaborative nature of human beings, and the importance of collaboration for learning.

On a similar view, within e.g. educational psychology, culture has likewise been argued to be the cornerstone of learning (Brown, Collins and Duguid, 1991). In a criticism of the structure and practices of traditional educational systems which separate *what* is learned

from *how* it is learned, Brown et al. (1991) argue that learning and cognition are situated, and states that "activity, concepts, and culture are interdependent. No one can be totally understood without the other two. Learning must involve all three" (Brown et al., 1991, p. 249).

Echoing the sociocultural theory of Vygotsky (1978), the authors stress that in order to learn to use physical tools, as well as conceptual knowledge, characterised as an abstract tool, students must be enmeshed within a community and its culture, where learning is unfolded within the process of enculturation and where collaboration within the culture leads to the understanding, reflections and discussions of concepts and strategies (Brown et al., 1991). The concrete actions of this kind of learning should occur in the following sequence: 1) in an activity setting, teachers model strategies and provide their tacit knowledge to the students, 2) teachers support the students' own attempts, and finally, 3) teachers encourage students to continue on their own (Brown et al., 1991).

Lave and Wenger (1991) similarly describe how newcomers initially engage with a community of practice through legitimate peripheral participation, where tasks typically are short and simple, and often only enter actively into the beginning or end of a 'work-process'. By participation in the community, the newcomer then gradually becomes a veteran, and a full participant in a socio-cultural practice.

The theory of cultural learning is an important cornerstone of the problem-based setting we apply in educating student psychologists at the DCD clinic. For example, while practicing in the clinic students learn to apply the interactive assessment method known as dynamic assessment, which, similarly to cultural learning, rests upon the cultural-historical theory of Vygotsky, and which holds the concept of dynamic mediation as the key to learning in an interpersonal context. In the following, we first describe the concept of mediation and then describe how we have implemented the concept in our PBL setting.

MEDIATING-MEDIATED PBL PRACTICES

The concept of mediation is a central concept that the students in the clinic need to come to understand from a theoretical and a practical perspective, and in parallel a concept to which they themselves are *exposed* to through the teaching style we employ during their internship at the clinic. Students thus experience the concept of mediation from three different perspectives and at three different levels of learning: 1) as the interpreter of theoretical descriptions of the concept, 2) as the student clinician applying the concept with the clients in the clinic and 3) as the learner being exposed to the notion of mediation while being enculturated as a psychologist (during supervision etc.).

Dynamic assessment is a Vygotsky-inspired interactive approach to psychoeducational assessment with a clear purpose of teaching cognitive tools with the conscious, purposeful and deliberate effort to produce change in an individual (Haywood & Lidz, 2007). Within dynamic assessment, teaching is mediational rather than giving concrete answers, and the method strives to identify and support the individual's learning potential rather than to assess their current level of independent functioning. This focus overlaps with Vygotsky's concept of the zone of proximal development, where learning is seen as the individual's ability to learn with the support of more experienced teachers (Vygotsky, 1978). In this sense learning is very much a joint enterprise.

The concept of mediation is central to the dynamic assessment tradition, and draws on Vygotsky's (1978) initial theorising about the dialectic interaction between the learner and the teacher, where concrete or abstract tools are intentionally used to engage the participant as an active learner towards a predefined learning goal.

Activities of mediation provide the learner with practical metacognitive knowledge on how to resolve specific problems and the teacher with knowledge about the learners' learning potential and zone of proximal development. Crucially, the learner is explicitly *invited* to become an active agent in practicing newly learnt strategies, concepts and metacognitive knowledge, but also in determining how to self-regulate his/her own learning. In this way, the programme strives to develop the students' intrinsic motivation to learn. According to Haywood and Lidz (2007) intrinsic motivation is associated with persistent and diligent learning in which students learn effectively, showing good retention of knowledge, while displaying a preference for novelty and complexity.

As mentioned, the theoretical framework underlying the PBL setting of the DCD clinic rests on the principles of dynamic assessment, which is practiced by the students across two intertwined levels of learning and practising. On the initial level, students first become familiar with the theories and concepts underlying dynamic assessment and with concrete case studies, where the principles of dynamic assessment are applied. This theoretical practice is introduced during the student's 1st semester and in conjunction with their gradual introduction to the daily activities of the clinic, which mainly consists of peripheral participation (Lave & Wenger, 1991) during booster sessions led by 3rd semester students.

An additional example of how the notion of apprenticeship is experienced by the students during their 1st semester in the clinic is in the students' first meeting with the clients (children and families) referred to the clinic. The responsibility of the student during these meetings is to take minutes, to show the families the clinic's facilities, and in a follow-up team meeting to pinpoint the specific challenges articulated by the respective families. During this early stage, the role of the student is more or less that of an observer who is

invited to participate in the phase of identifying the specific psychological challenges that need addressing in the clinic, but still without holding any professional responsibility. In the subsequent semester, the students become responsible for practising the principles of mediation in closely supervised dynamic assessment sessions with individual children in the clinic, and are also responsible for informal counselling with the parents.

At the end of the 1st semester, the students' newly gained theoretical and applied knowledge and their assimilation of an extensive compulsory literature is assessed through a graded oral examination. During this stage of learning, the students seem to fluctuate between acts driven by extrinsic motivation and acts driven by intrinsic motivation, with much focus on rote learning of the literature, and detached from their own professional and original reflections.

On the one hand, the students' participation in the practical activities in the clinic mostly seems driven by an intrinsic motivation to gain their first real-life psychologist experience in a real setting, despite this not leading to a specific grade or credits. On the other hand, their concentrated effort to do well on the curriculum-based formal evaluation of their theoretical knowledge seems to reflect an external motivation driven by the desire to gain a good grade *per se*.

This contrast is quite intriguing given that the students are clearly aware that the theoretical knowledge behind the principles of dynamic assessment is necessary for them to be able to plan and execute dynamic assessments in the clinic in the following semester. Nevertheless the underlying motivation of the students to internalise the theoretical knowledge often seems highly extrinsically driven. Original or real intrinsic motivation only emerges as the students enter into their main internship period during their 2nd semester. Here they finally get to "meet the client" and are given the major responsibility of planning and conducting the assessment.

Students also engage in regular supervision meetings during their internship in the clinic. Again the principle of mediation derived from dynamic assessment is central with the purpose of fostering more advanced metacognitive and reflective thinking in the students. In this way the framework unfolded in the PBL setting of the clinic appears in two planes: first the supervisors guide the student in how to apply the principles of mediation in real-life psychological and clinical settings, and in parallel to this, the students themselves are exposed to mediation-based supervision related to their own clinical work. Together these two co-existing levels of learning can be understood within the learning context we have called *mediating-mediated practices.*

THE CIRCLE OF ENCULTURATION – THE CASE OF DANISH CHILD PSYCHOLOGISTS

The specific professional knowledge students learn during their higher education may change rapidly, as the field develops. This stresses the crucial necessity for students to learn *how to learn* within the context of PBL, rather than just *what to learn,* and provides them the opportunity to internalise principles that may serve them in their lifelong learning.

Students in the DCD clinical programme typically go on to work in positions within the are of child psychology. In fact, the majority of Danish psychologists working with children and adolescents are employed in public Educational Psychological Counseling Units (PPR) (Danish Psychologist Organization, 2021). These are interdisciplinary units including a variety of professionals such as psychologists, speech and language therapists and special educational consultants.

Models and practices of working amongst Danish psychologists in Educational Psychological Counseling Units comprise a huge variety of intervention methods, from an indirect, consultative approach to interventions and assessments delivered by the psychologist directly to the child (Deloitte, 2020). Regardless of the intervention, *cooperation skills* are deeply embedded in the culture of Danish child psychologists, and where there exists a common agreement that one can never evaluate a child without taking into account the specific context, including families, schools, kindergartens, hospitals, psychiatry and doctors, etc.

In the following section we present a model that describes how PBL is unfolded through the process of enculturation in the case of the University clinic. The model is adapted from the PBL tutorial cycle, formulated by Lu, Bridges & Hmelo-Silver (2014) (see Figure 1).

The overall setting of the clinic provides students to work in reflective teams of four, centred around one specific child and its family. One student holds the main role as the student therapist, and is responsible for the assessment and intervention of the child. Another student colleague is responsible for informal counselling with the parent(s) of the particular child, while the remaining two team members carry out systematic observations of the dynamic assessment techniques applied by the student therapist in order to provide feedback and manage the technology (audio and video recording) during the therapy session.

Based on the information gained from the assessments with the child, the parents and other professionals, e.g. school teachers, the students in collaboration with the two supervisors meet and discuss how to generate hypotheses about causes behind the

challenges observed during the assessment and reach agreement about appropriate psychological support that should be provided to the child in the next therapy session. During this circular learning process, students immediately identify gaps in their existing professional knowledge and are encouraged to return to the research literature to find suggestions and specific professional tools. This supervised preparation nested within the PBL setting provide students with opportunities to engage in self- and other-directed learning on how to prepare concrete sessions of assessment and intervention directed towards a specific child and concrete challenges.

After each intervention session, students view the video from the session and select concrete challenges, which are then discussed in the following supervision meeting with the reflective team and the supervisors. Supervision sessions are led by open-ended and Socratic questions such as 'why do you think the child responded as he/she did? Why do you feel the session went well/not so well? What additional knowledge is needed in order to test specific hypotheses regarding the challenges and learning potentials that seemed to present themselves? Do you know of concrete tasks or materials that could be used to mediate a targeted response within the child? How did the parents address this notion?' In addition to this, supervision involves concrete guidance on how to prepare for and proceed in the next therapy session.

The dialogues arising between the student therapist, the reflective team and the supervisors offer an opportunity to discuss and reflect upon the 'how' and why' of Danish psychological practices and to challenge students' novice understanding and interpretation of children's behaviour. The students' established theoretical knowledge, together with the experience they gain through their PBL practices, provides a basis from which they gradually come to understand the professional world of Danish psychologists and to comprehend the complexity of this practice, which we address as the activity of learning how to 'wear psychologists' glasses and feel comfortable'.

After attending a supervision meeting the students plan the next therapy session, potentially revising their initial problem formulation and hypotheses, and the circle of enculturation continues, but now at a deeper level, allowing the students to identify new facts, etc. During the process of planning the sessions and preparing for supervision, students become enculturated into the practice of psychologists, and this activity is mediated through their acquaintance with new experiences, new knowledge, understanding theoretical concepts in practice, and applying psychological assessment materials, but also importantly by practicing the use the professional concepts, language, perspectives and logic of Danish psychologists.

Figure 1 illustrates the components of the process of enculturation, where the students collaborate, articulate and reflect on their learning under supervision. After completing

the final therapy session, the students collaborate with the supervisors in writing an assessment report, which includes recommendations for future pedagogical practices that can be applied in the child's home and school and which is then presented by the student at a final meeting with teachers and parents. The assessment report is an official requirement of the Danish Psychologist Association.

Once having passed the 2nd semester and the clinical internship, the now 'experienced' 3rd semester students are in a semi-independent fashion allowed to lead a short 'booster session' and now responsible as role models for integrating the newly-arrived 1st semester students as 'peripheral participants' (Lave & Wenger, 1991) in the initial stages of the 'Circle of Enculturation'. This allows the newcomers to gradually achieve full, legitimate participation in the specific community of practice by learning from the more advanced students, which seems to descrease their level of anxiety.

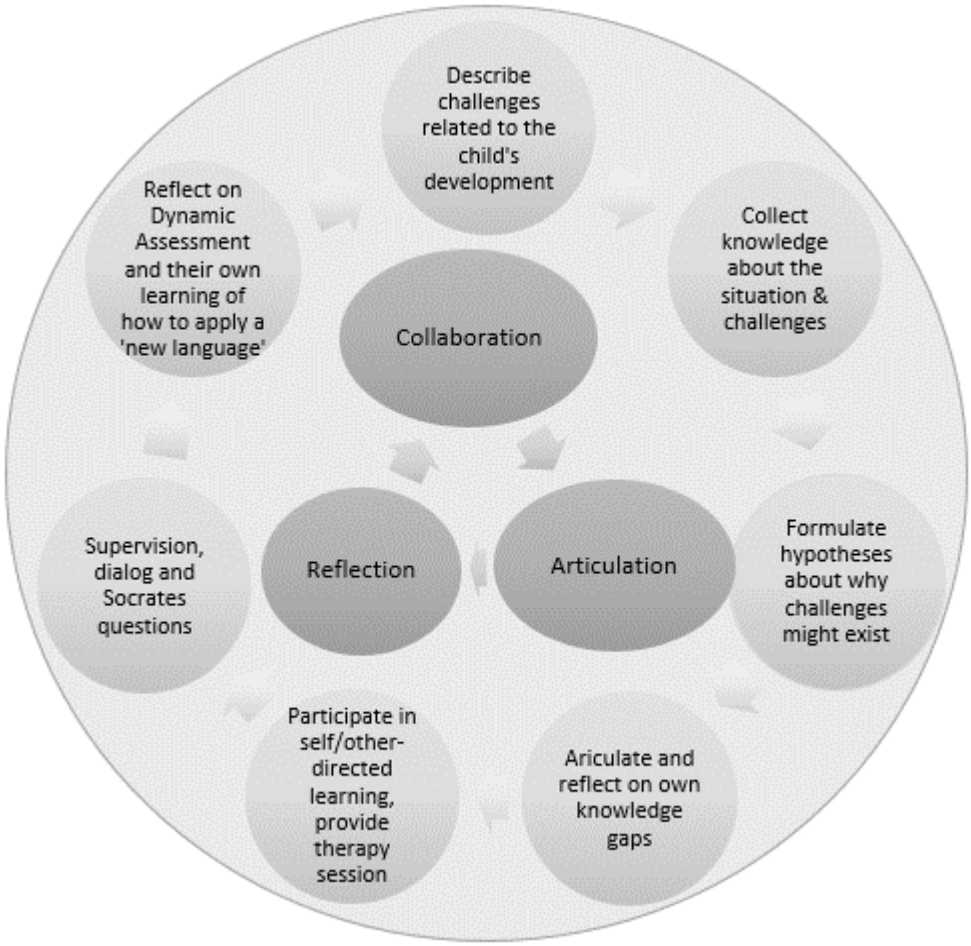

Figure 1. The Circle of Enculturation (adapted from Lu, Bridges & Hmelo-Silver (2014) 'The PBL tutorial cycle'.

Learning is reciprocal and the particular questions, thoughts, ideas and evaluations proposed by the students to the supervisors during their PBL learning situations contribute crucially to the ongoing improvements and adjustments made to the concrete setup and learning practices in the clinic and to the ongoing development of the culture of the clinic. In this way, each group of students leave their personal traces in the clinic, despite them not necessarily being conscious of having done so.

MOTIVATION AND PROBLEM-BASED LEARNING

As mentioned earlier, a key concept behind all learning is motivation. In the case of our PBL in the clinic, low levels of motivation are sometimes identified at the beginning of the 1st semester, which is the semester of transition from the heavily theoretically-based BA programme to the applied MA programme. In this semester, students are obliged to read heavy loads of compulsory theoretical and empirical literature in order to provide them with a minimally sufficient knowledge of the area in which they will work during their internship.

As described above, once entering their 2nd semester and initiating their main period of internship, the students become responsible for planning and executing continuous sessions of dynamic assessment with a child or adolescent and are also responsible for providing psychological consulting to the family. During this semester, we always observe an extensive blossoming of original intrinsic motivation among the students, enmeshed within the development of close long-term relationships among the students, and long working hours in the clinic, while preparing sessions or reading and understanding assessment tools. Interestingly, the semester of the internship is actually not a graded course, which emphasises the point that motivation must have other drivers than high grades. In order to earn credits, the student needs to be actively attentive during the internship and to write a report describing the internship based on reflections of their own learning process during their internship, which is then graded pass/fail.

So the question remains, why does intrinsic motivation increase with the disappearance of the grade system as a final reward? In our experience this is caused by the students' personal PBL experience of finally being able to identify themselves with real-life psychologist practices, as they now are being challenged in how to reach psychologically-based solutions to complex problems, and given original responsibility for real people in real-life situations, albeit under very close professional guidance and supervision. Interestingly, the responsibility arising from forming part of the reflective teams in the clinic, even if this only implies low-level practice activities, is taken very seriously by the students.

In the educational literature, it has been suggested that motivation can be enhanced through increased feedback from the other students or teachers (Dolmans & Schmidt 2006). In the clinic, the students receive feedback from colleagues, supervisors, children (e.g. did they understand or enjoy the therapy?) and the parents immediately after their therapy session, a factor which also seems to contribute to their increased motivation at this stage of learning.

CONCLUDING REMARKS

As addressed by Wiggins et al (2016) PBL processes often are not clearly psychologically informed, and little is yet known about how PBL is used in psychology courses in higher education. When educating psychologists we face the pedagogical challenge of closing the natural gap between the protected life as a student studying to become a professional and the scary high level of responsibility demanded when working in a healthcare profession.

In this paper we have introduced the theoretical framework underpinning the development of a concrete PBL Masters programme in the psychology department of Aalborg University, and how the programme can facilitate students' enculturation into the discipline of psychology. Furthermore, we have illustrated the learning process as the circle of becoming enculturated as a Danish psychologist.

The student- and practice-centred model is expected to bridge the culture of higher education and the culture of child psychology as a professional discipline, and thereby narrow the gap that causes stress and anxiety in the students, thus boosting self-efficacy. The PBL model offers the opportunity to learn *how to learn* as opposed to *what to learn*. Finally, we argue that the changes we experience in the students' motivation from extrinsic to intrinsic during their transition from being exposed to distally defined psychological concepts to actively experiencing conceptual meanings through real-life PBL activities occurs as a dialectical process providing the students with a stronger identity as a child psychologist.

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[1] Education for psychologists in Denmark consists of a 5-year university degree that leads to a professional qualification (MSc in Psychology; Danish: Cand.Psych.). In discussing the content of the 5-year curriculum leading to the protected title of Cand.psych., we term this the psychologist programme rather than the psychology programme. We use the term 'student psychologists' to refer to individuals specifically studying to practise as psychologists, as distinct from those studying psychology as a major.

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Exploring Transition in Higher Education: Engagement and Challenges in Moving from Teacher-Centered to Student-Centered Learning

*Judith Awacorach, Iben Jensen, Inger Lassen, David Ross Olanya, Hanan Lassen Zakaria, Geoffrey Olok Tabo **

ABSTRACT

The overall purpose of this study is to prefigure the feasibility of Problem Based Learning (PBL) for building research and employability capacity of MA-students in the context of Gulu University. Following a description of the basic tenets of PBL, we explain how PBL was used in experimental community outreach workshops for MA-students between 2016 and 2019. More specifically we identify traces of traditional learning practices and discuss to what extent the new learning approach might change the student-teacher power relationship. Methodologically and analytically, our study draws on a practice theory model developed by Kemmis and Mutton (2012). Although our findings indicate subtle traces of a traditional student-teacher relationship, the analyses indicate that the PBL learning mode is a promising candidate for strengthening research capacity in view of preparing students for post-graduate employability and community transformation. The workshops were organized collaboratively as part of the Danida-funded programme Building Stronger Universities.

Keywords: PBL, practice theory, qualitative methods, quality teaching, Uganda

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INTRODUCTION

The educational system in Uganda currently undergoes important changes. Since its introduction in the British colonial era, it has followed the same conventional post-colonial learning approach even after Uganda gained independence in 1962. Recently, however, employers in the private and public sectors have been complaining that graduate students do not have the skills needed in present-day society, and to comply with these requirements Gulu University has taken the first step into a process of transforming education. In Uganda, there is a growing interest in higher education, not only as a source of knowledge generation, but as part of the solution to community problems. Many ideas have centered on technical education, entrepreneurship education, and information communication technology as components of generic competencies required in view of job opportunities after university education. This relates to the fact that university education is considered to play a major part of the solution to community problems.

This article presents an emerging Gulu-Aalborg model, which is one of the international efforts of Gulu University to work for 'community transformation' in higher education in a local context. To achieve this objective, the article shares experience of students and supervisors, working together with community enterprises and organizations to share knowledge and to find possible solutions to societal problems through a problem based learning approach in post-graduate education. Focusing on the specific case of PBL workshops held at Gulu University in Uganda between 2016 and 2019, the study throws a critical gaze at the educational practices that have dominated higher education in the context of Gulu University. As an important part of our inquiry, we explore traces of traditional practices and architectures as they operate in a new social space, and we discuss how traditional practices may have a bearing on relations among students and teachers in a changing site of practice where interpersonal relationships find a new balance. This may give rise to contestation, tension and discursive struggle, thus inviting questions about what actions are possible to participants when new power dynamics are at play (Mahon, Francisco and Kemmis (2017, p. 20). We analyze and discuss this overall problem by asking the following research questions:

1: To what extent do traditional learning practices leave traces in a student centered learning space aimed at promoting post-graduate employability and community transformation?

2: How are discourses and inculcated practices negotiated among students and supervisors in the new student centered learning and research context?

RESEARCH CONTEXT AND BACKGROUND OF THE STUDY

Gulu University (GU) was established by statutory instrument in 2002 as one of the public universities to increase access to higher education, which was one of the post-war recovery programmes initiated by the government of Uganda. Since then the university has been growing steadily with approximately 240 academic staff members and more than 4,000 students. The university plays a major role in stabilizing the area, and it operates under the motto: for community transformation. Though a relatively new university and one of the smallest higher education institutions in Uganda, GU was ranked as the seventh best university out of 44 Ugandan universities in 2019 (UniRank, 2019). GU has six faculties and two institutes and it offers undergraduate, postgraduate and doctoral degrees in several study areas, including medicine, agriculture, science, education, law and business and development studies. Teaching methods have so far followed a teacher-centered approach for content delivery, but according to a management decision from 2011, student-centered pedagogy is now gradually being introduced in some of the programmes and courses.

At Gulu University, PBL is primarily being introduced in graduate education, with the first cohort of master programmes in social sciences and humanities. The aim of introducing PBL is to transform or complement the existing delivery of higher education in social sciences and humanities. Elsewhere PBL has found its usefulness in health sciences without adequate appreciation in Uganda's higher education. For example, Makerere University health sciences restructured their programmes to accommodate PBL where students, put in groups of five to ten, worked together with a facilitator or faculty member to explore what they need to know more about, but the problem was selected and prioritized by a faculty member. The approach has thus been teacher-oriented. In order to institutionalize delivery, they borrowed the idea from Moi University in Kenya, Maastricht in the Netherlands and Newcastle in Australia (Kiguli-Malwadde et al. 2006). Similarly, Mubuuke et al. (2016) showed the importance of students' experience in a tutorial for designing a feasible facilitation delivery guide. They found that most students demanded comprehensive feedback. We have seen fewer attempts at pedagogical change in the social sciences and humanities than in the health sciences. Firstly, most of the PBL has been documented across the health sciences in Uganda and particularly at Makerere University. Secondly, most of the information has focused on technical guiding, and also student-facilitator interactions through tutorials and feedback sessions. Thirdly, the focus has been on undergraduate education since 2003/2004 academic year.

WHAT IS PROBLEM BASED LEARNING?

Problem based learning is an approach to learning where students explore a problem, which is often an ill-structured societal issue that they explore to reach a solution or to obtain wider knowledge. A problem combines theoretical and experiential knowledge to a learning context in which a group of students take ownership of and share responsibility for the individual and social learning processes of the project (Kolmos, Fink and Krogh, 2006).

PBL scholars and practitioners (e.g. Kolmos, Fink and Krogh (2006), Krogh and Jensen (2013; Barrett, 2017); Jensen and Lassen (2019)) refer to seminal work by Dewey 1916, Piaget 1974, and Freire, 1972 when describing the philosophical principles behind PBL as being rooted in democratic ideology and learning rights of the individual. There are almost as many definitions of PBL as there are scholars, but among scholars who offer centrality to a problem-driven learning process we find Barrows and Tamblyn (1980), who define problem based learning as "the learning that results from the process of working towards the understanding of a resolution of a problem" (in Barrett, 2017).

Although the majority of literature on PBL has been written by Western scholars, the philosophy behind student-centered learning approaches is mainly attributable to the Brazilian educationist Paulo Freire (1972), who argued that only learners who become "knowing subjects" will have the capacity to change socio-cultural reality as a crucial aspect of transformative learning (Jensen and Lassen, 2019; Armitage (2013, p. 3). In a similar vein, Dewey (1916) developed a theory of learning based on the idea that as members of a group, individuals have learning rights that are best developed through practice, actions and experiences (Jensen and Lassen, 2019, p. 4).

Since the first attempts at introducing student-centered learning, PBL has spread to 500 higher education institutions (Servant-Miklos, 2019), addressing problems across disciplines. There is great variation in how PBL is taught in different universities, but in words borrowed from Servant-Miklos (2019, p. 3) the principle still stands that learning "begins with a realistic problem tackled by a small group of students in a class guided by a tutor who does not lecture but helps the students structure their learning".

In a Danish context Illeris (1974) conceptualized problems-based-learning through his master piece entitled 'Problem orientation and participant direction: An introduction to alternative didactics'. This laid the foundation of new didactic concepts such as problem-orientation and participant direction in the sense that learning departs from subject related knowledge, methods and theories of relevance to a specific problem identified and defined by the students. This would guarantee that students would find the problem

relevant and be absorbed in the learning process (Krogh and Jensen, 2013, p. 23). An important element in the learning process is that of gaining experience by learning in context. This is done through exemplary practice which requires that the student engages in a deeper understanding of contextual dimensions of a complex problem statement (Kolmos, Fink and Krogh, 2006, pp. 11-12).

On the African continent, there has been a general interest in exploring new learning approaches in higher education, but experiments with PBL carried out in South African universities have at times met some resistance among staff. Objections have been raised on grounds of heavy demands on resources and time to be vested in project work, and the problem of high student-teacher ratios has been raised as an issue. It has further been noted that institutions are "stuck in the old non-democratic, teacher-centered practices" (Mahlomaholo, 2013; Jensen and Lassen, 2019, p. 4). Irrespective of such objections, other experiments – especially within the medical field – have indicated that PBL has many benefits to offer. This is corroborated by an example from Cape Coast University in Ghana, where PBL was implemented in the curriculum in 2007 (Amoako-Sakyi and Amonoo-Kuofi, 2015; Jensen and Lassen, 2019).

In a Ugandan context, Makerere University's Faculty of Medicine introduced PBL in their five bachelor programs. However, according to Kiguli-Malwade et al., (2006) this was a very new approach regarding the role of expert in the process, where some members reportedly did not understand the new curriculum. Thus, lecturers complained of their changing roles and they found that tutoring was not rewarding and very time consuming (Kiguli-Malwade et al., 2006). Similarly, Makerere College of Engineering, Design, Art and Technology (CEDAT), together with consortia in East African Universities (Nairobi, Dar-es-Salaam) collaborated with Alto University in Finland to foster an innovative approach to higher education in plastic recycling (CEDAT, 2018). In contextualizing this to social sciences and humanities, the Faculty of Business and Development Studies and Faculty of Education and Humanities have been experimenting on PBL at Gulu University since 2016, in view of introducing PBL into graduate education. Both faculties have recently reviewed graduate degree curriculums while experimenting with students and facilitators through workshops, seminars and outreach activities. In Uganda, the need for Higher Education is to help the students develop higher order subject and generic competence on the basis of university experience. As such, little attention has been given to higher education improvement, experience and engagement with the community in general.

Problem Based Learning and Practice Theory

Practice theory is a relatively new philosophical-sociological approach formed by a critique of the dualism, for example between actor and structure, body and mind,

individual and collective, micro and macro. Practice theory is based on the assumption that social action (the practice) is a precondition of all existence. According to this view, the practice concurrently constitutes both the subject and the object. Practices train subjects to develop certain ways of acting and handling objects (materiality). Likewise, the objects form the subject (Schatzki, 1996; Reckwitz, 2002; Kemmis & Mutton, 2012). Furthermore, a practice is characterized by being recognizable by persons who are familiar with the practice (Reckwitz, 2002), and by being related to normativity (Rouse, 2007). All practices are thus a performance of social negotiations regarding what is deemed as appropriate in a specific practice. According to Theodore Schatzki practices are defined as organized nexuses of actions. This means that the doings and sayings composing them are interrelated. More specifically the doings and sayings that compose a given practice are linked through 1) practical understanding, 2) rules, 3) a teleoaffective structure, and 4) general understandings (Schatzki, 2002, p. 77).

The Australian researchers Stephen Kemmis and Rebecca Mutton (2012) have operationalized the main lines in the work of Schatzki in their well-known model (shown below) in which they illustrate how practices are interconnected and how a practice seen from the side of individual can be described as the practitioners' diverse arrangements.

<table>
<tr><td colspan="4">Individual side ← Practice → Extra-individual side</td></tr>
<tr><td colspan="2">Projects/teleoaffective structures
How purposes and intentions expressed by practitioners direct activity</td><td colspan="2">Practice landscapes
How practitioners and objects are enmeshed and entangled in activity and how materiality, rules, and procedures prefigure actions by infrastructural sedimentations</td></tr>
<tr><td>Practitioners' characteristic 'sayings'</td><td colspan="2">← How 'sayings' performatively enacts a practice in semantic space through language →</td><td>Cultural-discursive arrangements</td></tr>
<tr><td>Practitioners' characteristic 'doings'</td><td colspan="2">← How 'doings' enacts a practice through the medium of activity and work →</td><td>Material-economic arrangements</td></tr>
<tr><td>Practitioners' characteristic 'relatings'</td><td colspan="2">← How 'relatings' enact power and solidarity →</td><td>Social-political arrangements</td></tr>
<tr><td colspan="2">Dispositions/practical understandings
How actors are attuned to participate in practices, how they have a 'feel for the game', and how they know how to 'go-on': practical knowledge, skillfulness, and appraisal of specific values.</td><td colspan="2">Practice traditions/general understandings
How current practice is enacted to reproduce or transform the traditions and history of the local practice or—more broadly—in relation to the traditions and history of practices that span multiple sites.</td></tr>
</table>

Figure 1. Elements of practices and practice architecture in the site (adaptation from Kemmis et al. 2014, p. 38-39).

Sayings, Doings, and Relatings refer to the way actors talk and act and relate to each other regarding the practice under examination. *Cultural-discursive arrangement* refers to established or appropriate ways to talk about e.g. students and teachers. Some discourses will describe students as independent actors and learners while other discourses will describe students as passive subjects. *Material-economic arrangement* refers to formal rules and regulation and materiality in the field. It could for instance be rules in the curriculum. *Socio-political arrangement* refers to for instance a political goal for the university as for instance Gulu University, working for social change and innovation.

Kemmis and Mutton argue that these different arrangements add up to a practice architecture in which practices are interconnected and a configuration of one another (Kemmis et al, 2012). According to Kemmis et al. the overall consequence of this assumption is that "We cannot transform practices without transforming existing arrangements in the intersubjective spaces that support practices*"* (Kemmis et al.,2012, p. 6). Therefore, "sayings, doings and relatings of one practice are shaped by the sayings, doings and relatings of *another* practice" (ibid.).

METHODOLOGY, ANALYTICAL FRAME AND DATA

Methodological approach

The method used in this study can be characterized as practice theory combined with what the Swedish sociologist Mats Alvesson (2003) describes as self-ethnography, although our study was conducted as a team. "A self-ethnography is a study and a text in which the researcher-author describes a cultural setting to which s/he has a 'natural access' and is an active participant, more or less on equal terms with other participants. The researcher works and/or lives in the setting and then uses the experiences, knowledge and access to empirical material for research purposes" (Alvesson, 2003, p. 174). The methodological affordances of producing self-ethnography as a team has the strength of not being subjective because all interpretations have been discussed from different positions of experience.

Analytical approach

The analytical affordances of practice theory is that because focus is on practices rather than on subjects it opens up for a general understanding of how practices are carried out. Another analytical affordance of practice theory is the assumption that a practice never occurs in isolation but always must be understood (read) as interconnected with other practies. Each practice is imbricated in a practice architecture (Kemmis & Mutton, 2012). This has implications for our analysis of possible interconnectedness of traditional practices and the newly introduced PBL and research practices, as they unfold in the

discourses (sayings), practices (doings) and relatings (power). Together these discourses and practices form the mainstay of the practice architecture. Analysing these elements will help us prefigure the feasibility of PBL for building research and employability capacity of students. Against this background practice theory, practice analysis and PBL seem to inform each other in useful ways.

In this article, we will use the model shown in Figure 1 as our analytical frame. This means that the analysis will begin with a description of the traditional practice architecture, focusing on the material-economic arrangement and 'doings' in terms of how teaching has been organized traditionally. Subsequently, we focus on interpersonal relationships and the discourses that enact these social-political arrangements.

Workshop format

The three research capacity building workshops we focus on in this article were planned jointly by a planning group consisting of three lecturers from Gulu University and three lecturers from Danish Universities. The programme was tailored to students from the faculty of Business & Development and Faculty of Education & Humanities during their first year of post-graduate study. At the end of 2019, more than 150 students had been introduced to problem based project work through practical experience and interaction with external stakeholders. Lecturers (around 25) from the two faculties were trained in project supervision in previous training-of-trainer workshops held by partners from Denmark, and supervision skills were further developed through the practice obtained in the course of the workshops. The planning process, which took place via Skype meetings, began several weeks before the actual workshops and found a final form in two courses: one for students and one for supervisors. The planning group met with supervisors two days before the actual workshops were to take place, offering tutorials on PBL, student-supervisor relations, qualitative and quantitative research methods, ethics and data analysis.

During the workshops, students would plan how to collect data, prepare data collection instruments and, after prior agreement with stakeholders, they would do fieldwork such as interviewing, distributing questionnaires or making observations. The next two days were spent on data analysis, interspersed with tutorials in support of their work. The final day of the workshop was set aside for presentation of projects and results. In addition, the students were allowed to replace 50% of coursework by a project report to be submitted by each project group. This was in accordance to provisions for coursework in the curriculum. (For a description in more detail, see Alidri, 2019).

Description of data

For the purpose of this article, we used three categories of qualitative data as illustrated in Table 1.

Post-workshop questionnaires (supervisors)
Post-workshop questionnaires (students)
Audio-recorded debriefing meetings (students)
Audio-recorded debriefing meetings (supervisors)
Observation of practices

Table 1. Types of qualitative data.

Post-workshop questionnaires for staff and students were used to assess and share the experience of engaging in problem based project work compared to traditional lecture based method. In the questionnaires, supervisors and students were asked to evaluate the workshops in terms of learning outcomes and possible challenges they had met from exposure to a new learning practice. The questionnaires asked supervisors and students to evaluate the research process, including ethical issues and letters of consent. The participants also assessed to what extent they had been able to use the learning management system (Moodle) in the workshops.

The debriefing meetings took place at the end of each workshop day. The aim of the debriefing meetings was for the workshop facilitators to closely follow the process of each project group. Because of the large number of students, each project group sent a representative to report on the activities and possible challenges of the day. This made it possible for the students to obtain advice on how to solve any pertinent issues and for the workshop facilitators to offer additional input if required. In a similar way, the workshop facilitators arranged debriefing meetings with the supervisors to enable the supervisors to voice any concerns about the project groups they were supporting. This resulted in a request for an additional tutorial because supervisors as well as students had expressed concern that they needed more knowledge about qualitative research methods to be able to apply it in their PBL projects.

Observation of practices aimed at understanding what learners and teachers were doing, saying, and how they were relating in a traditional setting versus the PBL environment, with a particular focus on the power relations between the students and supervisors (teachers).

ANALYSIS AND DISCUSSION OF FINDINGS: CHANGING PRACTICES

Traditional order of practices – classroom observation

To have an impression of traditional practices and content delivery at Gulu University, we had observed class teaching as practiced in the normal routines of the institution. In what follows, we exemplify this by representing our observations of a course taught to 60 first-year undergraduate students. The classroom, which was highly congested, had chairs placed in rows all facing the teacher's desk. Students chose a seat as they entered the room, bringing notebooks and pencils. The teacher opened the class by writing the topic of the day on the painted blackboard. For a start, the teacher revised last week's questions and some students were called to the blackboard to make an analysis.

Material-economic arrangement in the traditional order

The learning situation was characterized by teacher-centeredness as the teacher was at the forefront throughout the class – apart from intervals when students did independent work or group work. The students performed traditional student roles, answering questions and taking notes. Apart from ten students who were active, raising their hands when questions were asked, the vast majority of the students were silent and inactive in the situation. At times, the whole class would answer simultaneously in chorus, and we noticed that humour played an important role in keeping the students' attention. The 3-hour slot was structured by the teacher and varied between teacher-student interactions, the teacher asking comprehension questions, individual work and presentations on the blackboard. After two hours, the students were asked to go into groups, which created a very chaotic situation due to the congestion and high number of students, and it took a while before work could be resumed.

Social-political arrangement (interpersonal relations) in the traditional order

The teacher was a friendly and likeable person, who often shared laughter with the students. S/he seemed very interested in the students' learning process and asked probing questions to check understanding. S/he praised those students who performed well in class and reproached, warned or made slight fun of those who did not. From time to time, s/he included elements of obligation like "your notes should be read in your free time and not in class". There were also examples of reproach and mild threat as in "Some were not here last week. I don't know why…those who missed the lecture have missed out" or "You do not have much time before November", thus warning students about the upcoming exam period. These examples indicate an unequal power relationship between the students and the teacher who was in control of the situation through a constant focus on the subject matter and through shared humour, at times at the expense of a student not able to answer a question. Overall, however, the atmosphere in the classroom was good although many of the students seemed timid and performed traditional student roles.

Material economic arrangement in the changing order of practices

For a discussion of the first research question, which aims at following a trajectory of traditional learning practices into the new transformed site of engagement, we find it relevant to compare the 'doings' of the material-economic arrangement (Kemmis and Mutton, 2012; Mahon et al., 2017) with the practice architecture prefigured in the problem based learning workshops. In line with Mahon et al, 2017, we look more closely at changed aspects of the physical environment that may shape the actors' doings and sayings. These may include material aspects such as buildings, furniture, audio-visual equipment, timetables, access to support and ratios between teachers and students (ibid).

Whether education follows a teacher-centered or a student-centered approach, the point of departure is a material-economic arrangement represented here by curriculums approved by university management and relevant accreditation boards. Before making the workshop experiments with PBL, we had mapped current curricula for three MA programmes: Master of Education in Education Management, Master of Business Administration and Master of Public Administration and Management. We had done this to identify courses that would be suitable for introducing problem based learning. We found that the traditional curricula had described the following modes of delivery: classroom teaching, formal lectures, question & answer sessions, explanation, drilling, group discussions, presentations, case studies, and guest lectures (MBA, 2010; MED, 2015).

Unlike what we had observed in traditional classroom teaching as described above, the PBL workshop made it possible to avoid a high student-teacher ratio and congestion of many students in one room. This is corroborated by the following observation by a supervisor who makes implicit reference to classroom limitations: "This was so good and has added a lot to our learners which we could not have covered in class" (Post-workshop evaluation 2016). Instead of chairs organized in rows that faced the blackboard, the chairs and tables used for group work were placed in such a way that the participants were able to face each other for ease of interaction. More often than not, groups had organized themselves with a table and chairs outside the classroom, and they only entered the classroom for input or debriefing at the end of the day. Because of the reorganization of classroom activities, the supervisors also found themselves in new locations instead of lecturing in front of a blackboard. This gave the students possibilities for working independently, and supervisors were able to attend to other activities and only intervened at critical moments in the process, such as problem identification or fieldwork preparation.

Because the project was designed as an ICT-supported activity, the students brought laptops to the site, and unlike what was the case for traditional classroom-teaching,

students used the Internet for literature search and for project planning purposes. The location of the first two workshops was in international hotels with internet access; however, the last workshop in 2019 was held on university campus in a new building constructed for problem based project work. The building, which was originally a container, was equipped with a router for internet connectivity and furnished with tables and chairs to accommodate more than 50 people.

Although there were many power cuts during the project period, the use of ICT-technology did assist the whole planning process. In the first two workshops, it was possible to communicate changes in the time schedule to workshop participants via Moodle, and in the third workshop, changes in the schedule could be projected at the beginning of each workshop day. Using the Internet for literature search made the students more independent and responsible in terms of deciding on readings, and it released the teachers from the task of providing texts for the students. However, some supervisors drew attention to a lack of basic ICT skills and one respondent commented that "participants lacked not only PCs but also basic skills in ICT", while another supervisor made the point that "supervisors should acquaint themselves more than the students to Moodle usage" (post-workshop evaluation 2016). This indicates that in the new learning situation, some supervisors implicitly traced a trajectory of absent skills back to the traditional practice architecture.

Socio-political arrangement (relational practices) in the changing order or practices

Drawing on Kemmis and Mutton (2012) this part of the analysis focuses on 'relatings' in the socio-political arrangement in order to answer our second research question, which we repeat here for convenience:

How are discourses and inculcated practices negotiated among students and supervisors in the new student-centered learning and research context?

We then discuss the socio-political arrangement in relation to the 'sayings' of the cultural-discursive arrangement as the two arrangements are intertwined and seem to inform each other.

Social-political arrangements: student conceptions of supervision

The overall impression from the post-workshop evaluations was that the students appreciated the assistance by their supervisors very much. Comments like: "The presence of supervisors was a strength – everybody was very much interested" (debriefing 2016) or "there was free interaction between supervisors and students" (post-workshop questionnaire 2016), which prefigures a change in the traditional power hierarchy of teacher-centered learning. However, the evaluations also included comments like: "I

think as students we need to listen and be guided although supervisors shouldn't be rigid to what they already know" (Post-workshop questionnaire 2016), Here the student alludes to a situation when a supervisor does not accept that students should take responsibility for their own project, indicating a trace of a traditional power relationship.

When asked about possible challenges in the group project work, some students mentioned the problem of identifying 'dependent and independent variables' when doing qualitative research. This was also mentioned by a supervisor who commented: "it looks as if most of the groups were having problems with Dependent and Independent variables [….]". The issue of variables points to a specific research approach that originates in quantitative research as used especially in natural science. This approach is somewhat at odds with the participatory design of PBL and points to taken-for-granted perceptions about 'a correct research approach'. The issue of variables and values also came out in relation to challenges experienced with identifying a problem for exploration. One student mentioned that "supervisors disagreed over approach – this confused us – should we go by values or …." (debriefing 2018). The comment indicates that this group of students expected the supervisors to tell them which approach to choose, in line with traditional teacher-centered practices. This leads us to the next section where we focus on some aspects of supervision.

Socio-political arrangements: supervisors conceptions of students practicing PBL

In one of the debriefing sessions, the supervisors were asked to comment on possible challenges in relation to introducing PBL. Many comments from supervisors indicated that the concept of PBL was not clearly understood by students, and the supervisors positioned themselves as more knowledgeable than the students, as shown in the example: " [….] Yeah, eventually when we noticed misconceptualization of PBL, we had to explain to them what PBL means - we also guided them in terms of what they don't understand [….]" (debriefing 2018). In this example, the supervisor construes the students as 'not knowing' and the supervisors – 'we' – as knowledgeable and experts on PBL. According to this representation, the supervisors 'explained', they knew 'what PBL means'. In the utterance, the supervisor positions the students and the supervisors at two levels of a knowledge hierarchy, which may be seen as a characteristic trace of traditional socio-political 'relatings (Kemmis and Mutton, 2012).

A similar power balance may be seen from the following excerpt, however with the important variation that the supervisor gives the students space for negotiation and discussion among themselves:

> So these students had not met although they registered but they had not met among themselves as a group…to do a project on the topic... and therefore to bring them

> at par was not easy …until I called my troops … my fellow supervisors ….you guys, let us break off from these students so that they can first discuss among themselves …And then after some time we went back, and we found … they were not conclusive on what to do. …they were somehow thinking of something which was outside the topic… and we said ….no no no, you stick to your mandate until you come up with something and then you can start. But along the way, we found they were not understanding the problem. So we said – you guys – you first understand the problem…. And then we gave them another break…and they sat among themselves ….so it took us long to …but eventually they are doing something (debriefing 2018).

In the excerpt, the students are construed as uncertain about how to go about identifying a research problem. Instead of making any decisions on behalf of the students, the supervisor suggests to the fellow supervisors that the students need time to get acquainted with each other and to begin discussing a possible problem for exploration. The supervisor positions him/herself as leader of the group of supervisors – 'my fellow supervisors … you guys, let us break off', which indicates an unequal relationship with co-supervisors. At the same time, the supervisor seems to position the group of supervisors in a relationship with the student group that allows the students freedom to discuss – while still controlling the process ('no, no, no, you stick to your mandate until you come up with something and then you can start'). The supervisor and his/her fellow supervisors thus seem to establish two kinds of power relationships with the students; on the one hand, the supervisors control the process and take on roles as more knowledgeable on PBL, and on the other, they still allow the students space to do their own project. They thus perform the role of facilitators, guiding the students.

Towards analytical synthesis

The analysis began with an observation of practices in a traditional teacher-centered learning classroom. This was an important point of departure for studying how students and teachers practiced learning in a new problem based learning context. Following Kemmis and Mutton (2012), we structured the analysis round three perspectives reflecting practitioners' characteristic ways of 'doing' (material-economic arrangements), 'saying' (discursive arrangements) and 'relating' (social-political arrangements). In the material-economic perspective, we looked at 'doings' in terms of how a practice architecture prefigures what can be said and done in prevailing discursive practices. We then combined the cultural-discursive perspective with the socio-political perspective by analysing how 'sayings' and discourses enact 'relatings' to form shifting power relationships.

As for discourses, one may notice that the cultural-discursive perspective was enveloped in a grand discourse of education. This was predominant in the traditional teacher-centered approach as well as in the problem based approach. However, there were slight differences in that in the observation of traditional teaching, teachers tended to focus very much on what students must do to learn the subject matter of what was taught, in order for them to be able to pass the exam. By contrast, the supervision sessions were discursively oriented towards problem identification, methodology and independent project group work with the aim of solving a problem in society. One may thus notice some negotiation going on between a traditional education discourse and a discourse of 'educational emancipation', in which students and teachers strike a more balanced power relationship. It is worthwhile noting that the new orientation towards problem identification through project group work in collaboration with external stakeholders may open a door to future interaction with enterprises and organizations outside of university. This may pave the way for students to obtain a job as they become more acquainted with the local community. The following statement by a group of students who worked on a project on water supply seems promising in terms of future community engagement:

"the district environmental officer went on to show us about causes of water shortage [….] we went up to pumping stations and talked to people. To us this was really more than we had expected. People were asking: are you coming with solutions?" (Debriefing 2016)

Overall, we found that there was a close relationship between the three perspectives of 'doings', 'sayings' and 'relations' in that changes in practice architecture opened up to new ways of physical and spatial organization, which in turn stimulated free interaction among students and between student groups and their supervisors. There was a marked difference between some of the practices observed in the traditional classroom and the practices in the changed environment in terms of 'sayings' and 'relatings'. At the same time, what was said – the discourses – influenced how the participants related to each other. This said, is was, however, still possible to trace some reminiscence of traditional teacher-centered practices in the discourses circulating in the interaction, not least in terms of power relations between students and supervisors. This may be seen, however, as a necessary aspect of project supervision where supervisors may be seen as 'midwives' who have to accept some aspect of control of the process as we saw in the excerpt above. However, we also observed that the way problem based project work opened up to engagement with stakeholders in the local community was a motivating factor for changing supervision practices in that the students were 'set free' to interact independently with enterprises and organisations in the local community.

CONCLUSIONS – SIGNIFICANCE OF A PROBLEM BASED APPROACH TO EDUCATION

Participants generally expressed a high level of appreciation of the new learning approach tested in the workshops. This appears from a typical comment in the workshop evaluations: "To us it has really been more than what we had expected […] if this workshop was conducted earlier we would have excellent performance in all subjects [….] People (in the community) were asking: are you coming with solutions? And one of the hotel owners said: do not let lecturers do this as a joke – we need it" (debriefing 2016). The teachers embraced the student-centered learning approach in the PBL workshop and meetings, however without entirely leaving behind inculcated practices from traditional teaching.

The PBL workshop enabled both teachers and students to interact with the community through their research projects and engagement with peers. Although the community had varied needs and interests regarding their problems, the external stakeholders, who participated in the projects, seemed very keen on interacting with the students. However, student reports showed that assumptions do not always align with community expectations, and the research activity led to addressing some of the community problems and also influenced practices. The students reported that their problem formulations were modified to community challenges in the field, indicating that initial surveys are important in contextualizing real life problems. The problem based approach thus seems to offer new entry points into employability of post-graduate students, thus contributing towards solving the problem raised by employers in Gulu District and corroborated by the Inter-University Council for East Africa (IUCEA), who claimed that there are "long-held concerns among employers that most graduates are not fully prepared for the job market" (Nganga, 2014).

From the narrow perspective of learning, the workshop situation was highly motivational to the students, who competed for producing the best output in their presentations and some reported that it had enhanced their research capacity. Some of the students later on reported that they got promotion on their jobs since they could practice the skills they acquired from the PBL workshop to perform their jobs. On this basis we find that PBL is a promising approach for preparing post-graduate students at Gulu University for employability and community transformation.

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Problem-based Learning in Institutional and Curricular Design at the New Model Institute for Technology and Engineering (NMITE)

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ABSTRACT

NMITE's Master's in Integrated Engineering (MEng) was created with a unique philosophy of integrating not only traditionally separate strands of engineering, but also of integrating engineering with other disciplines such as arts, humanities, and business. This broad and deep integration is made possible by adopting the principles and practices of problem-based learning (PBL) and embedding them within predetermined module challenges. In this way, each PBL challenge highlights and hones areas of engineering expertise and embeds liberal subjects whilst maintaining the integration intrinsic to the programme. Overall, this method supports the use of block learning with deep integration of employers and the community in the educational experience.

Keywords: Integrated Engineering; Curriculum Design; Engineering Education

INTRODUCTION

NMITE believes PBL can be a "change-agent" in a new model of engineering education, and that it can help open the engineering profession up to new and different kinds of thinkers and practitioners with the potential to achieve great things (Saven-Baden, 2000). Indeed, the creation of NMITE was motivated by the belief that engineering education, both in the UK and globally, can and should increase its potential, and that the current prevailing methods of educating engineers are not as effective as they could be (Perkins,

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2013; Perkins, 2019; Engineering UK, 2016; Wakeham, 2016). This new model has high-stakes implications: the need to educate passionate, curious, resilient, and agile engineers equipped with the skills and motivation to solve pressing problems may never have been more urgent. With a shortage of engineers entering the workforce and a surplus of "gigaton problems [that] need gigaton solutions" from climate change to clean water to resource scarcity, a change in engineering education is long overdue (Xu et al., 2020 p. 4037). At NMITE, the embedding of PBL within the pedagogical approach has a critical part to play in meeting this goal (Institution of Engineering and Technology, 2019; Usher & Sheppard, 2017).

To fully develop and test this approach, and prior to its first cohort in September 2021, NMITE utilised a year-long Design Cohort activity, based on Olin College's "Partners", that brought student co-design into plans for both the institution and the MEng programme (Miller, 2019). Learning with and from over 30 members of the Design Cohort has strengthened NMITE's PBL pedagogy and practice, expanding our conceptualisation and producing a truly innovative programme. By designing for PBL the programme enables students to become agile, intellectually curious graduates with the broad skillsets necessary for future employment.

BACKGROUND

NMITE is a new Higher Education (HE) provider in Hereford, England. As its first and therefore flagship programme, the MEng has been created using best practices used elsewhere in schools and HE, innovatively combining them to produce a unique pedagogical design, curriculum content and assessment approach. Revamping engineering education "requires commanding the whole problem, not just iterative efforts that barely strike a moving target."[1] It is not enough to make gradual, minor adaptations to existing educational models; rather, the change society needs requires a wholesale shift in mindset, pedagogy, and practice. The destination – graduating work-ready engineers – may be similar to that of other engineering programmes, but the NMITE road map is completely different. It has been drawn from scratch to take students on a journey whose landmarks include not only the achievement of technical skills, but also those of personal and professional development cited by recent governmental and professional body reports (RAEng: *Engineering Education systems that are fit for the future, 2018*) as necessary to 21st century engineering work. These include incorporating creativity into engineering (Awang and Ramly, 2008; Felder, 1988); broadening the diversity of students (Busch-Vishniac and Jarosz, 2004; RAEng, 2019); strong emphasis on project work (Grolinger, 2011; Savin-Baden, 2000; Perrenet et al., 2000); industry engagement in design and delivery (Burns and Chopra, 2017); experience of the workplace for students (Lee et al., 2010); and greater interdisciplinarity within and beyond engineering (Richter and Paretti,

2009). All this is accomplished on an accelerated timetable taking students from entry to Master's in only three years.

Beginning with a blank page has allowed NMITE to make these additional components integral to every landmark on the Master's pathway and to deeply embed them within the programme philosophy and design. Whilst still adhering to the high standards expected by the Engineering Council, the MEng learning journey will look different from the very first moment a student enters NMITE and uses a PBL approach through Engineering Sprints, multiple Community-Based Challenges and the completion of independent Bachelor's and Master's projects.

LEARNING APPROACH: INTEGRATED AND INTERDISCIPLINARY

An NMITE student realizes that engineering is at its heart all about systems and connections, and that the best engineers understand how economics, geopolitics, culture, technology, and values work together to enable it. Indeed, Popper states "We are not students of some subject matter, but students of problems. And problems may cut right across the boundaries of any discipline."[2] This is why NMITE's MEng uses PBL to integrate conventionally separate strands of engineering and goes still further – integrating engineering with other disciplines such as arts, humanities and business (Braßler, 2020; Navarro et al., 2016). Unlike traditional degrees where options to take outside subjects are available but not part of a coherent programme of learning, NMITE's integrated approach means these subjects are not isolated and all disciplines inform all learning at every stage. Engineering challenges are designed in such a way that the implications of other disciplines for engineering, and the interactions between technical and non-technical considerations, are fully woven into the learning throughout the degree. Indeed, liberal elements comprise 30% of the MEng programme. Communication and ethics are required components of every PBL challenge, and these concepts and skills are built upon with increasing complexity as students advance through the programme.

Using the strengths of a PBL approach, NMITE explicitly defines places within the curriculum where distinct professional behaviours and competencies are developed (Lucas and Hanson, 2016). The programme goes still further, deliberately embedding increasingly complex learning types across the Framework for Higher Education Qualifications (FHEQ) levels (which in the case of an integrated Master's is FHEQ 4-7), moving from passive to interdependent and directed to reflective learning as the programme progresses. This approach using PBL enables a natural and unobtrusive transition from extrinsic to intrinsic motivation (Talmi et al., 2018; Lam et al., 2009) and moves the student up the learning taxonomy from fundamental knowledge and application to synthesis, evaluation, and phronesis (Frigo et al. 2021). Ultimately, this

educational model provides the basis for industry-ready engineering capability as well as the foundation for lifelong learning. To demonstrate this, Figure 1 provides a pictorial overview of the programme with details on competency and learning development; progression of technical techniques and professional behaviours; and awareness of social engagement and responsibilities.

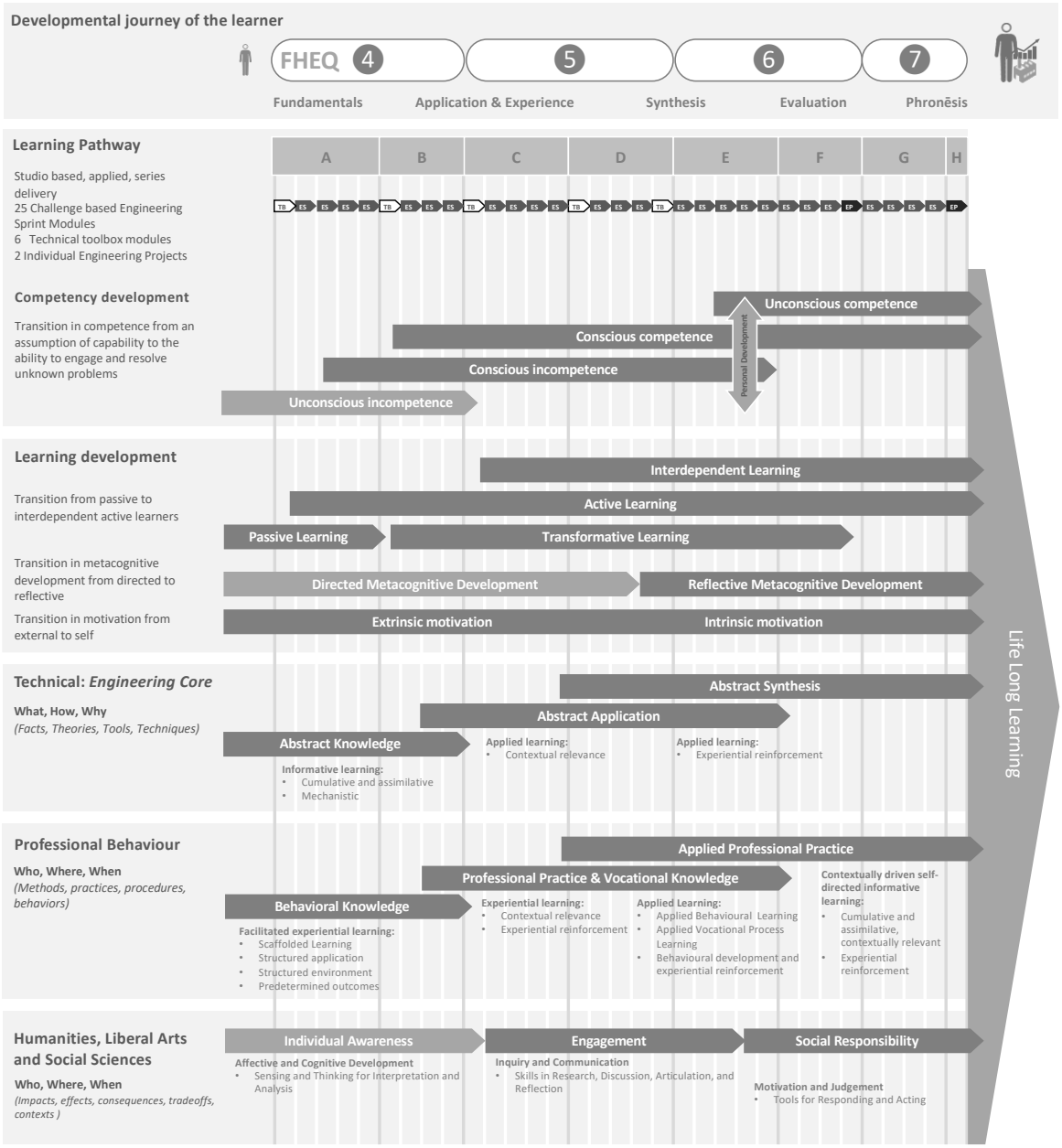

Figure 1. The NMITE educational model.

Thus, using a pedagogical approach made possible through the utilisation of PBL, NMITE has maintained a strong focus on the engineering discipline, while further enhancing it by including broad-ranging intellectual and personal discovery. Taken

together, this integration of the technical and non-technical, the personal and the professional, enables learners to be both students and solvers of problems.

LEARNING STYLE: CHALLENGE-BASED AND ENGAGED WITH PARTNERS

NMITE is dedicated to the philosophy that education should integrate learning with experience, so the MEng content is always connected to real-world and tangible challenges. After all, "Having learned it is not as good as having seen it carried out; having seen it is not as good as understanding it; understanding it is not as good as doing it."[3] Therefore, educators and partners work collaboratively to develop PBL challenges that respond to specific problems and alongside specific stakeholders. Students will immediately understand that engineering does not happen in a vacuum: the need for engineered solutions arises because of problems situated within industry and communities. They will quickly come to know that a successful solution depends on stakeholder engagement, effective communication, and project management, and they will discover and practice multiple ways of achieving that success. By the time they finish their degree, they will have worked on over 26 real-world challenges, including examples such as flood-monitoring systems, wearable respiratory pollutant alarms and portable energy provisions.

At NMITE, the contextual nature of PBL also extends beyond the technical. Real-world partner engagement provides a pathway for exploration, awareness, and understanding of the economic, social, ethical, cultural, and political elements of engineering, for example the financial and ecological impact of a new transport route. In this way, these non-technical aspects become part of, rather than tangential to, engineering practice. The immediate and repeated exposure to and engagement with communities and industry enables students to gain and develop the professional skills and experience that often take years to develop in the workplace. This not only emphasizes the importance of effective communication and collaboration at every stage, but it also provides for a smooth transition from the world of school to the world of work and offers entry into professional networks long before graduation.

LEARNING COMMUNITY

The process of creating NMITE included significant stakeholder engagement with the aforementioned Design Cohort, industry, and community leaders. The Design Cohort product-tested and critically analysed and evaluated the effectiveness of PBL learning in a small community via seminars, tutorials and directed activities. They confirmed that an emphasis on teamwork, using contextualised challenges rooted in industry and

community needs, mirrors a workplace setting. Furthermore, by including educators from areas outside engineering disciplines, NMITE's model enabled effective learning environments that encouraged individuality as well as fulfilling end-user, professional needs. The Design Cohort demonstrated that the learning community is a team on a shared journey: Educators act as guides and mentors; students are equipped with the tools they need to succeed but are given the independence to use them on their own. They provided each other with constructive input and feedback. They learned together. They overcame obstacles. They shared their achievements. They exemplified the essence of problem-based learning.

With the MEng programme design rooted in the ambition to broaden pathways into studying engineering, NMITE's admission processes also identify those students who combine academic ability with resiliency, curiosity and passion, the capacity to develop life-long learning skills, and those who value work-life experience. At the core of NMITE's curriculum design, culture and ethos is the intent to develop a high quality, safe-to-fail PBL environment which provides students with the understanding, knowledge and experiences that will ensure that they are work-ready upon graduation. Therefore, in addition to the traditional (or alternative) academic thresholds, NMITE includes a novel approach to recruitment that assesses individual and team potential and capabilities and offers the opportunity to demonstrate the same qualities that we need in professional engineers: curiosity, passion, resilience, creativity, and insight.

LEARNING DELIVERY

NMITE's sequential modules mainly fit into two categories: Toolboxes and Engineering Sprints. Toolboxes are 2 or 3 weeks long and introduce students to skills and concepts that they will use throughout the remainder of the programme and long into their professional careers. In contrast, Engineering Sprints are typically 3.5 weeks in duration, during which students encounter 26 real-world PBL challenges that they grapple with as teams in a studio environment. As with any engineering problem, each challenge will however automatically and inherently include several subject areas. So although a module may focus primarily on a single topic, in reality it will contain multiple cross-disciplinary elements in an integrated way emphasising the value of our PBL approach within a real-world context. The following subject areas are included within the NMITE MEng Programme:

Subject areas included in *Engineering Sprints*	**Subject areas included in *Toolboxes***
Engineering Materials and Processes	Rhetoric and Communication for Engineers
Electrical and Electronic Engineering	Engineering Design
Statics and Structures	Metrology
Programming	CAD Exploration and Drawing
Integrated Systems	Observant Engineering
Flow, Heat and Energy	Technical Project Management
Dynamics	Engineering in Art
Electromagnetics in Engineering	Design of Experiments and Statistical Analysis
Structural Materials and their Innovation	Creativity
Control Systems	Teams
Energy Systems	Communicating
Manufacturing Systems Optimisation	Engineering Business Strategies
Solid Mechanics	History of Engineering
Thermal Fluids	

Table 1. Subject areas within NMITE's Master's in Integrated Engineering.

As students progress through the degree, challenges become more demanding, needing an increasingly interdisciplinary approach that requires both engineering and broader expertise. Later challenges are built around the thematic areas of Infrastructure, Health, Security and Energy and the impact that future engineers will have on developing sustainable, appropriate, affordable solutions within these areas. PBL enables assessments that mimic the deliverables that engineers must produce in their careers, align with the challenge subject matter, and provide an appropriate vehicle for students to demonstrate comprehensive understanding (Jones et al., 2013).

Additionally, communication and mathematics knowledge is ubiquitous and embedded in the service of project completion rather than presented as topics taken alongside technical coursework. NMITE views both mathematics and communication as vital tools for engineers but does not believe a high level of mathematical or English knowledge should be a pre-requisite for starting an engineering degree. In line with its overall learning style, NMITE will support and scaffold mathematics and communication learning 'through doing' as part of the various modules that are offered. Learning and applying mathematics and communication in this deeply contextual way is both effective and engaging for most engineers and is analogous to the way these topics are experienced in the workplace (Schettino, 2016).

Thus, through PBL, students are doing more than creating technical solutions by solving equations and applying theoretical principles in the service of a product. They are learning to balance the desire to satisfy customer needs with the pressure to create a technically

sound prototype. They are gaining experience in product testing, team management, and risk analysis. All this is achieved within a compressed timescale where they can be solely focused on one challenge, where they combine motivation and self-belief with resilience, and where the feedback they receive develops both competence and independence in learning how to learn.

The sequential and modular delivery of the MEng facilitates the accelerated and focused approach, as well as enables reinforcement and achievement of professional outcomes beyond technical expertise. Sequential learning allows students to build upon prior knowledge in a coherent and structured way, while modular learning enables dedicated, in-depth focus on particular topics and projects. This style of PBL delivery makes integrative learning more feasible, which facilitates knowledge transfer between disciplines.

CONCLUSION

NMITE was established to add value to a profession that is critically important globally, and to enrich the existing menu of options for students who want to study it, with the knowledge that "The ideal engineer is a composite . . . not a scientist, . . . not a mathematician, . . . not a sociologist or writer. But [she or] he has to use the knowledge and techniques of any or all of these disciplines in solving engineering problems."[4]

With a new and different approach to engineering education centred in best practices of PBL, NMITE dispenses with the one-size-fits-all model of learning and challenges the stereotypical and limited idea of what it means to be an engineer. In doing so, we both improve educational practice to the benefit of students and communities, and make a positive impact on companies, industries, and the challenges they exist to solve.

Based on the PBL results of educational experiments elsewhere, engagement with our Design Cohort, and extensive consultation with academics, engineers, industry representatives, and the community, this bold new programme will produce the graduates we need: engineers who are excellent communicators, instinctive collaborators, broadly trans-disciplinary in their approach to problems, and ready to craft creative and innovative solutions for their employers, their communities, and the world. Aptitude for this kind of engineering practice depends as much, if not more, on attitude as on accomplishment. Therefore, through NMITE's distinctive PBL educational model, we are determined to educate engineers who are willing to take the risks needed to be the creative problem-solvers society needs, and who are able to be innovative, entrepreneurial, and resilient in the face of as-yet unknown challenges. In examining and evaluating their own ideas as well as existing thinking, they will not just be able to know if and how they can do something, but also ask if and why they should.

Acknowledgement

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Applying Neuroscience Concepts to Enhance Learning in an Online Project-Based Learning Centered Course

*Joao Alberto Arantes do Amaral and Felipe Fregni **

ABSTRACT

This case study presents our findings regarding a Project-Based Learning Course, where we applied neuroscience concepts to make the learning experience more effective. The course, which followed a combination of project-based learning and flipped classroom approaches, was delivered during the first semester of 2020, to 20 graduate students of the Faculty of Education of the University of Sao Paulo, Brazil. We explain the course design, curriculum, and online components. We collected data from course questionnaires and analyzed them qualitatively. We found that the course fostered long-lasting learning, by allowing the students to connect theory and practice, by providing knowledge-sharing opportunities and by promoting the retrieval of the content learned. We also found that course design allowed continuous improvement of course, learning environment and activities, that also enhanced the learning experience. Our findings also suggested that the usage of flipped-classroom concepts improves the efficacy of the online meetings. Finally, comic strips' usage brought humor to class, helped the students fix content, and contributed to reducing the stress that the students were facing.

DESCRIPTION OF THE CONTEXT

In this case study, we present the lessons learned about the application of neuroscience concepts in a course developed in a distance-learning environment. The course, entitled ‘Project-Based Learning’ was delivered to 20 graduate students from the Faculty of Education from the University Sao Paulo. The graduate students were teachers from several public and private schools in Sao Paulo. The course followed a project-based

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learning approach. The seven-week long course began in the middle of May and ended by the beginning of July of 2020. The course aimed to teach the students project-based learning concepts in conjunction with neuroscience concepts. The course was delivered during the Covid19 pandemic; therefore, it had several constraints to its implementation. The first constraint was the students' availability. Since all the students were also teachers, almost all of them were deeply involved in restructuring their teaching courses. The restructuring process required a huge workload: consequently, they had limited time to perform graduate activities. The second constraint was the students' psychological conditions: all of them were confined in their houses with their families in a stressful condition for a number of them. To make things worse, many of the students had no previous experience designing and delivering online courses and had to do it rapidly. Therefore, the confinement and the job's challenges were causing a stressful situation.

However, this negative context also brought benefits to our course. Since our first online meeting, it became clear to us that the students saw our course as the place where they could find answers to the new problems that they were facing. They were deeply interested in learning project-based learning concepts to apply them in the online courses they were delivering. They were also paying attention to the way we were conducting our course to replicate our practices in their courses.

In this case study, we began with a theoretical review of the neural mechanisms of the learning and two active learning approaches (project-based learning and flipped classroom) that could be used to improve learning. We defined our research questions and described the context of the experiment that was developed to investigate possible answers to these questions. After that, we described our research method and the way we used to gather and analyze data. In sequence, we discussed the results, performing qualitative systemic analysis. Finally, we presented the findings and the limitations of our research.

THEORETICAL FRAMEWORK

Neuroscience studies (Bransford, Brown, & Cocking, 2000; Hebb, 1949) revealed that the learning process leads to the creation of connections between several neural networks of different brain areas (Morris, Kandel, & Squire, 1988). Neurons connect each other by means of gates that are functionally modulated by neurotransmitters in the so-called synaptic junctions (Beale & Jackson, 1990). The long-lasting learning occurs when the connections between the neurons are strong and the networks are wide (Fregni, 2019; Sousa, 2010). Studies also revealed that images (such as comics) facilitate the students to understand abstract concepts and to make connections with real-world situations (Bolton-Gary, 2012).

Therefore, in order to foster long-lasting learning, teachers should stimulate the students to connect the new concepts with the concepts the students already know (Deshler et al., 2001; Fregni, 2019; Sousa, 2010). In doing so, the students create new neural network paths and thus create a more distributed neural network that facilitates long-lasting learning (Draganski et al., 2004).

However, synaptic strengthening may weaken over time. To avoid that, one should retrieve the information periodically (Karpicke, Butler, & Roediger III, 2009). Based on this concept, teachers should also provide opportunities for retrieving the concepts taught (Karpicke & Roediger, 2008) and allow metacognition to strengthen the connections between the neural networks.

Another important concept to enhance learning is to increase attention. Neuroscience researchers show that our brain filters out constant and repetitive information (Fregni, 2019): therefore, in order to foster learning, the teacher should change the type and the duration of the stimulus (Sousa, 2010). Finally, two other important factors can interfere with learning: stress and anxiety (Christianson, 1992). However, there is an important dose relationship for these factors. Too little and too much stress decrease learning (Christianson, 1992, Fregni, 2019), while moderate stress may be beneficial if related to the learning context.

Project-based learning (thereafter PBL) is an educational approach that can be used to foster long-lasting learning. It is a student-centered approach rather than teacher-centered. In a typical PBL-centered course, the students work collaboratively to find answers to a question, or to solve a real-life problem (Bender, 2012). During the project the students are challenged to work collaboratively, researching ways of finding solution to the proposed challenge (Savery, 2015). The project is used not only to teach academic content but also to develop critical thinking skills (Bell, 2010). The course is managed by the teacher as project, with well-defined milestones and deliverables (van Rooij, 2009).

Project-based learning centered courses foster students' interaction and class discussion (Pollock, Hamann, & Wilson, 2011). Also, it allows the teacher to provide feedback to the students (Larmer & Mergendoller, 2010). It also stimulates the students to ask questions and promote in-deep inquiry (Larmer, Mergendoller, & Boss, 2015). A well-conducted PBL course allows the students to reflect on the learning process itself (Blumenfeld et al., 1991). More than that, PBL allows students to learn by doing (Bender, 2012). During PBL centered courses, the teacher may change the type and duration of the stimulus, fostering activities that enhance motivation (Markham, 2003). Therefore, the PBL approach may provide opportunities to the students to connect the new knowledge with previous knowledge, may give occasions on retrieval and reflection, and may also

favor metacognition processes, the main issues that neuroscientists point that improve the learning experience.

Project-based learning may work better if the teacher challenges the students to study the class content previous to the class (Shih & Tsai, 2017). The strategy of providing means to the student to study the learning material previously to the class and use the class time to clarify their doubts is known as the flipped classroom (Bergman & Sams, 2012). The use of flipped classroom strategy may bring several benefits (Smith, 2017), such as improving student´s motivation and interest (Zainuddin & Halili, 2016), enhance the communication between the students and between the teacher and students (El Miedany, 2019), facilitate the group work activities and collaboration (Flumerfelt & Green, 2013), foster critical reflection (Roehl, Reddy, & Shannon, 2013), allows self-paced learning (Weng, 2015), facilitate differentiating instruction (Siegle, 2014) therefore enhancing the students' learning.

The neuro-scientific principles of teaching and learning are complementary and closely connected with the well stablished socio-constructivist principles of PBL (Savin-Baden & Major, 2004), which postulate that a student create knowledge based on his/her previous knowledge and experiences (Hendry et al.,1999) and by exchanging experiences with their peers (Richardson, 2003; Savery & Duffy, 1995).

The following figure (Figure 1) may help to have a better understanding that the comprehension of the mechanisms of neural learning can help the teacher to choose the educational approaches to foster learning. In this case study, we explore the application of only two approaches (project-based learning and flipped-classroom).

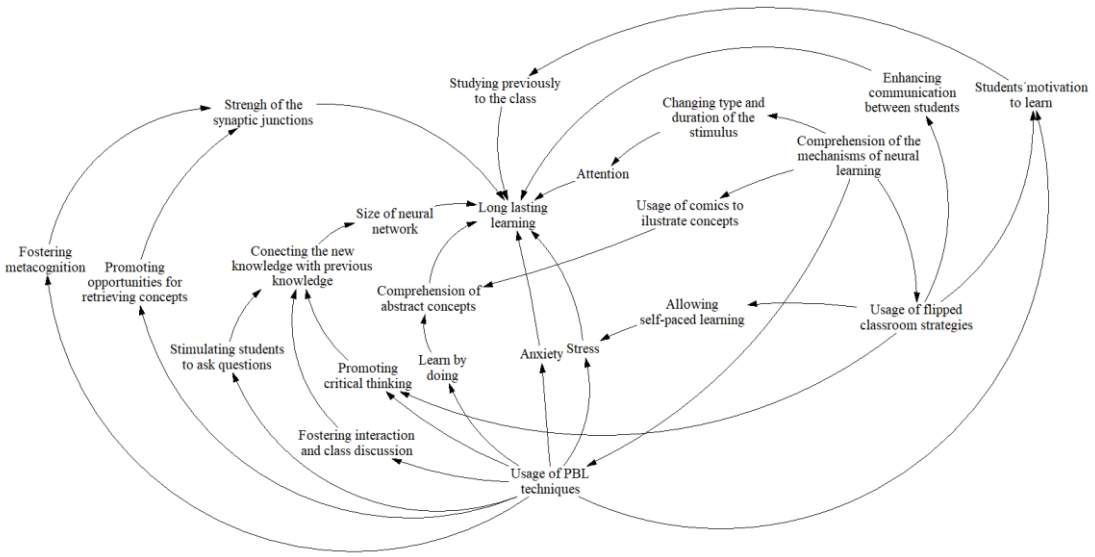

Figure 1. The comprehension of neural mechanisms of learning helps to choose the educational approach.

The 2020 Covid-19 pandemic brought several challenges to the students and the teachers (Toquero, 2020). The teachers were challenged to transform rapidly traditional face-to-face courses into online courses (Bao, 2020). They had to learn not only how to choose and use online learning platforms and tools, but also how to provide a meaningful learning experience (Reimers & Schleicher, 2020). The students were challenged to learn under stress in living conditions far from ideal (Cao et al., 2020).

Although scholars point out that PBL can also be applied in distance learning context (Arantes do Amaral et al, 2018), it seems that there is still a lack of information about the application of PBL programs in the context of Covid-19 pandemic online teaching. Our aim in this article is to understand how to maximize the learning experience in an online PBL centered course in the COVID-19 context. We also aimed to use neuroscience findings to discuss our results based on our course experience.

CONCRETE IMPLEMENTATION

Our course followed a PBL approach: it was designed in order to provide opportunities to the students to learn project-based learning concepts and experience them while accomplishing practical projects. The course was also designed to maximize learning by making use of neuroscience strategies to allow the students to connect the content they were learning with their previous knowledge and experiences (Appendix 1). The course was designed to provide the maximum of critical reflection and metacognition opportunities: the student would learn concepts, apply what they learned in projects, reflect on the learning process during the program and share insights with their peers. More than that, the course was designed using the flipped classroom concepts: the students were challenged to study the week material before each class. We designed the course this way to make online meetings more productive.

However, the course was delivered under the Covid-19 pandemic. As discussed previously, the students were under stress and had very limited time to accomplish course projects and interact with other students. Therefore, we decided that the projects would have a simpler scope, and the students would develop the project individually.

The course was developed in seven weeks (Appendix 2). Each week, the students were asked to read articles, watch short-documentaries, and read a chapter from the textbook (Fregni, 2019) and from the comic book (Fregni & Arantes do Amaral, 2020). Every week, the students had an online meeting (approximately two-hours long, on Mondays) with the teacher to discuss the activities accomplished during the week, clarify issues, and discuss the readings and videos and share experiences. After the meeting, the students were asked to answer a questionnaire (Appendix 3). The questionnaire had three

objectives: the first objective was to foster the students' reflection about the week's learning. The second objective was to identify what concepts the students didn't learn well. The third objective was to give the students the opportunity to suggest course improvements.

Every weekend the teacher read all the questions and created a short video providing feedback to the students. In addition to that (based on students' suggestions of course improvement), the teacher made adaptations in the way the course would be conducted in the following week. In doing so, the teacher provided continuous improvement in the way the course was conducted. This also increases the interaction by enhancing motivation.

The students were also required to deliver two small projects, one in week five and another in week six (Appendix 2). The projects were designed to allow the students to experience the challenges involved in PBL courses by doing two simple projects that lead to the creation of short videos. More than that, the projects also aimed to provide metacognition, given the students the opportunity to reflect on their own learning and share their findings with their peers.

In the final week of the course, the teacher asked the student to answer a final questionnaire about the teaching and learning strategies and material used in the course (Appendix 4). The questionnaire also provided two questions about self-assessment. The students' answers were the data used in our reflection.

RESULTS AND REFLECTIONS

The data of the final questionnaire was analyzed qualitatively. We used the language processing method (Shiba, Graham, & Walden, 1993) in order to organize the data in categories of recurrent themes (Bradley, Curry, & Devers, 2007). We proceeded as follows: first, we broke the answers of the students in sentences. Then compiled the similar sentences into categories of similar meaning and created a label for each category. After that, we reassemble the categories into broader clusters. Then created sentences (the recurrent themes) that summarized the mean ideas of each cluster.

In sequence, we performed a qualitative systemic analysis (Arantes do Amaral, 2019; Lalanda-Gonçalves, 2015) of the recurrent themes, using a system dynamics modeling tool, a causal loop diagram (Yearworth &White, 2013). We proceeded as follows: first, we analyzed the interconnection between the ideas expressed by the recurrent themes, representing the key ideas by means of variables and the connections by means of causal links (Senge et al., 2012; Sterman,2010). We identified the reinforcing and balancing feedback loops and connect then, creating a model of the relationships by means of a

causal loop diagram (Figure 2). The causal loop diagram allowed us to understand the systemic structure responsible for the patterns of behavior we observed in our course (Schaffernicht, 2010).

Results

Eight recurrent themes (therefore RT) emerged from the analysis of the students' answers:

RT1: The weekly questionnaires helped the students review and reflected on the course content and organize the ideas, therefore reinforcing the learning.

RT2: The articles were meaningful to the students, since they helped the learning, by providing the necessary theory and practical examples of applications of PBL in different educational contexts.

RT3: The videos were inspiring and interesting. They helped the students make connections between theory and practice, reinforcing the learning by providing the students with real-life practical examples of implementation of PBL. In addition to that, the videos also brought new insights to the students and helped fix the content and motivate them to learn.

RT4: The online meetings helped the students clarify doubts and have a better understanding of the readings/videos. More than that, it promoted knowledge sharing by the exchange of different points of view.

RT5: The comic book brought humor to the course, motivating the students to learn. The comic strips facilitated the learning of the neuroscience concepts; the images helped to consolidate the content and review and summarize the textbook concepts.

RT6: The online forum and the videos created by the students promoted intense knowledge-sharing opportunities. The students' diverse backgrounds brought different perspectives and examples. However, few students suggested that the course's platform chosen (Google Classroom) was not adequate for forum activities.

RT7: The weekly feedback provided by the teacher, by means of a video, helped the course to be improved week by week. More than that, it also promoted knowledge sharing, since the teacher summarized the main issues pointed by the students, clarified the doubts, and commented on the students' suggestions for the course improvement.

RT8: The students acknowledged that they intend to apply all the topics studied, in special PBL, CBL (Community-based learning), critical thinking in the courses that they teach. They also let us know that they intend to apply neuroscience concepts in their teaching activities.

Reflections

So, what did we learn from this course?

Going back to our research question, the data revealed that the teaching approach we followed (asking the students to review the material prior to the online meetings) worked very well. The students used the online meetings to clarify issues, rather than to watch teacher presentation. This finding is aligned with the findings of other scholars (Nam, 2017, Shih & Tsai,2017) that pointed out the efficacy of the use of flipped classroom in project-based learning online courses. The more the students studied before the class, the better the was quality of the online meetings, which led to an increase in the learning experience (Figure 2, Feedback loop 'Fostering pre-class content instruction').

We also learned that the videos, the accomplishment of the projects' activities, the reflection about the teacher's weekly feedback, and the readings helped the students associate the theoretical concepts with real-life experiences. These activities connected theory with practice, therefore fostering long-lasting learning (Figure 2, Feedback loop 'Fostering long-lasting learning').

In addition to that, the students' participation in the online forum helped the students learn with each other. Also, the video feedback from the teacher promoted an intense knowledge sharing and improved the connection between theory and practice (Figure 2, Feedback loop 'Promoting knowledge sharing').

The weekly questionnaires helped the students reflect on learning, retrieve the concepts studied previously, and strengthen the connections made, therefore contributing to the long-lasting learning (Figure 2, Feedback loop 'Providing retrieval opportunities'). The weekly questionnaires also helped the teacher to make quick corrections in the way the course was delivered, leading to improvements in the teaching and learning practices, therefore also favoring learning (Figure 2, Feedback loop 'Doing course-improvements').

We also learned that the comic book helped the student to have a better understanding of the concepts described in the textbook, helping the students to fix the contents. In addition to that, it also brought humor to the class, reducing, therefore the stress the students were facing (Figure 2, Feedback loop 'Bringing humor to the classroom') and making learning more enjoyable. This finding is also aligned with the results of other researchers (Supriatna, Fauzi, & Holilah).

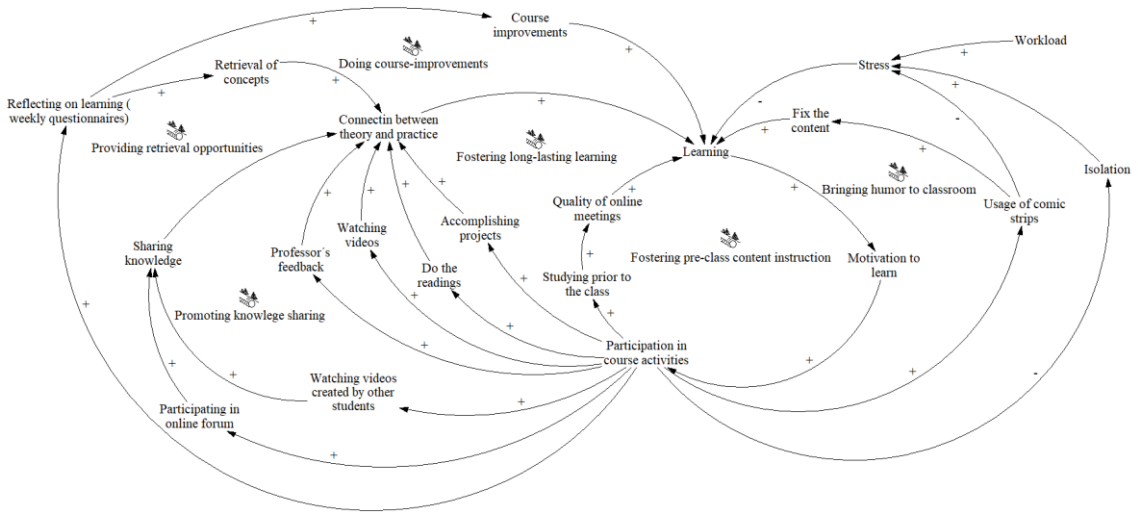

Figure 2. The course dynamics.

Limitations

In this case study the number of students was small (20). As this is qualitative research, we do not have the intention of generalizing the findings of the study. More than that, it is difficult to conclude that the learning that occurred in our course was only due to the application of the neuroscience concepts, as this was not a randomized controlled trial. The positive learning effects may have been due to other factors, such as the students' intrinsic motivation to learn as the students in this class could have been more motivated. We cannot exclude this possibility: however, based on the empirical data here presented, we may speculate that the utilization of the neuroscience concepts trigged the course's dynamics (the feedback loops we experienced in the program).

Another possible limitation is related to the evaluation of the long-lasting learning. We fostered, in many different ways (such as stimulating the students to connect the new concepts with the concepts they already know, by providing occasions on retrieval and reflection, by favoring metacognition processes and by challenging the students to study the class content previous to the class) the long-lasting learning. However, we may only speculate that the learning that occurred was long-lasting. In order to have more certainty about this issue we intend to accomplish another research, in a couple of years, with the same students, in order to verify if the long-lasting learning that we fostered in fact happened.

What could we have done differently?

Maybe we should have used a course platform with a better online forum that would allow better interaction between the students and the teacher. We may also speculate that, if we have given the students more complex projects and ask them to work in teams, they would have interacted more and learned even more. In an online learning context without Covid-19 pandemic, we certainly would follow that approach. However, with respect to the

students' stress and workload, we think that our choice was the most appropriate for the circumstances.

We hope that this case study can be helpful not only to PBL community but also for those interested in applying neuroscience concepts to their teaching and learning practices.

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APPENDIX 1

Neuroscience concepts used and the respective course design changes

- *Neuroscience concept 1 - It is important to enhance neural network connectivity for long-lasting learning:* The teacher should stimulate the students to connect the new concepts with the concepts the students already know. The students were challenged to create videos, explaining how they have used (or intend to use) the concepts studied in the courses they teach. More than that, they were also required to participate in forum activities, making comments on other students' posts.
- *Neuroscience concept 2 - Retrieval leads to long-lasting learning*: In our program, students had to discuss the material after reading and thus discussing several points of view - also, the lecture (flipped classroom) was a retrieval of their previous learning. In addition, every week, they were required to answer questionnaires about the material they have studied that week. They were also required to watch the teacher's feedback video (that presents a recapitulation of the main points of the week).
- *Neuroscience concept 3 - Our attentional system filters out constant and repetitive information:* To foster learning, during our weekly meetings, the teacher never made use of long PowerPoint presentations. Instead of it, the weekly meetings were shorts: during the meetings the teacher always changed the type and the duration of the stimulus. For example, sometimes, the teacher asked the students to discuss one article. After that, he changed the focus of the discussion, inviting the students to reflect on a video or a comic strip. Sometimes the teacher asked for volunteers to answer a question; sometimes he chose the ones who would answer.
- *Neuroscience concept 4 -Moderate stress may be beneficial if related to the learning context:* The students were challenged to create short videos. As many of them didn't have this expertise, it brought moderate stress. However, the videos were related to the learning context.
- *Neuroscience concept 5 - Learning that is more applicable to the student context enhances learning efficiency:* We used images (such as comics and videos) to facilitate the students to understand abstract concepts and make connections with real-world situations. In our program, students watched videos of innovative teaching and learning programs, where teachers make use of PBL and neuroscience concepts in classroom activities. In addition to that, the students were challenged to read comics and discuss how the situations portraited were related to their practice as teacher.

APPENDIX 2

Week	Week Goals and Activities
01	*Week goals: to learn the basics concepts of project-based learning and the neural basis of learning.* *Readings:* Read the article: "Gold Standard PBL: Essential Project Design Elements" (Larmer, 2015) Read the chapters 01 of the textbook Read chapters 01 and 02 of the comic book. *Videos:* "Project-based learning: success start to finish" (Edutopia, 2012) *Online forum*: participate by posing a question, answer questions of other students or writing a reflection about what you have learned this week. *Online meeting:* participate in debate, questioning or answering questions *Reflection about the week:* After the online meeting, answer the Questionnaire 01: Individual reflection about the first week of the course
02	*Week goals: 1) to learn the basic principles of community-based learning 2) learn how our memory system works* *Readings:* Read the article: "Combining community-based learning and project-based learning: A qualitative systemic analysis of the experiences and perceptions of students and community partners" (Arantes do Amaral, 2019). Read the book's chapters 03 Read the comic book's chapter 03. *Videos:* "Community-based learning: what is it? How can I do it?" (Watnee, 2015), *Online forum*: participate by posing a question, answer questions of other students or writing a reflection about what you have learned this week. *Online meeting:* participate in debate, questioning or answering questions *Reflection about the week:* After the online meeting, answer the Questionnaire 02: Individual reflection about the first week of the course
03	*Week goals: 1) to learn the challenges of implementing PBL in blended learning environments 2) to learn the relationship between motivation and learning 3) to learn about online learning challenges and opportunities* *Readings:* Read the article: "Lessons Learned Implementing Project-based Learning in a Multi-campus Blended Learning Environment" (Arantes do Amaral et. al (2018)) Read the book's chapters 04 and 07 Read the comic book's chapters 04 and 07 *Movies:* Watch the movies: "A student-centered model of blended learning" (Edutopia,2019) "Teacher-created videos for remote learning" (Edutopia, 2020)

	Online forum: participate by posing a question, answer questions of other students or writing a reflection about what you have learned this week. *Online meeting:* participate in debate, questioning or answering questions *Reflection about the week:* After the online meeting, answer the Questionnaire 03: Individual reflection about the first week of the course
04	*Week goals: 1) Learn what is critical thinking and how to apply it in PBL centered courses* *Readings:* Read the book's chapter 08 Read the comic book's chapter 08 *Movies:* Watch the movies: "Critical thinking with Garfield Gini Newman" (Edmonton Regional Learning Consortium,2016) *Online forum*: participate by posing a question, answer questions of other students or writing a reflection about what you have learned this week. *Online meeting:* participate in debate, questioning or answering questions *Reflection about the week:* After the online meeting, answer the Questionnaire 04: Individual reflection about the first week of the course
05	Week goals: foster the development of long-lasting learning by reviewing the concepts studied making connections with student's teaching practice. *Project:* creation of a five-minutes video, making connection between one topic studied and the working experience of the student as teacher. *Readings:* there were no readings this week, however the students were challenged to review the topics studied in previous weeks Movies: the students were asked to watch the movies created by their peers. *Online forum*: participate by commenting about the videos created by other students. *Online meeting:* participate in debate, questioning or answering questions *Reflection about the week:* After the online meeting, answer the Questionnaire 05: Individual reflection about the first week of the course
06	*Week goals: 1) Learn how to use arts to foster learning in different PBL centered course contexts 2) Create a video, using art to explain a concept studied previously* *Project:* Create a short-video (approximately 5 minutes long) using one form of art to explain one topic studied in the previous week. *Readings:* Read the articles: "Using the Arts to Foster Students' Interest, Engagement, and Learning in a Distance-Learning Environment" (Arantes do Amaral & Brito, 2018) "Using Group Drawings Activities to Facilitate the Understanding of the Systemic Aspects of Projects" (Arantes do Amaral et. al.,2017) *Movies:* Watch the movie: "The powerful effects of drawing on learning" (Edutopia,2019)

	Movies: the students were asked to watch the movies created by their peers. *Online forum*: participate by commenting about the videos created by other students. *Online meeting:* participate in debate, questioning or answering questions *Reflection about the week:* After the online meeting, answer the Questionnaire 06: Individual reflection about the first week of the course
07	*Week goals: 1) Learn the different ways of grading a PBL centered course* *2) Accomplish a self-evaluation* *Readings:* Read the book's chapter 09. Read the comic book's chapter 09 *Online meeting:* participate in debate, questioning or answering questions *Reflection about the week:* After the online meeting, answer the Questionnaire 06: Individual reflection about the first week of the course *Activity:* perform a self-evaluation

APPENDIX 3

Questionnaire

Question 01: Please let me know what you think worked in the course this week.

Question 02: Please let me know what you think didn't work in the course this week.

Question 03: What have you learned with the course activities of this week?

Question 04: Do you have any suggestions for the course's improvements?

APPENDIX 4

Course evaluation

Question 1: For all that we have studied in this course, what do you think can be useful for you to apply in the courses you teach?

Question 2: How did you like the weekly questionnaires (individual reflections)? (I would like to know if the questionnaires helped or not to your learning, and, if so, in which ways)

Question 3: How did you like the articles? (I would like to know if the articles helped or not to your learning, and, if so, in which ways)

Question 4: How did you like the videos? (I would like to know if the videos helped or not to your learning, and, if so, in which ways)

Question 5: How did you like the comic strips? (I would like to know if the comics helped or not to your learning, and, if so, in which ways)

Question 6: How did you like the experience of learning with your peers? (By means of participating in the online forums and by watching the videos they developed. I would like to know if the knowledge sharing helped or not to your learning, and, if so, in which ways)

Question 7: How did you like my weekly feedback? (I would like to know if my feedback helped or not to your learning, and, if so, in which ways)
Question 8: Which grade you would give yourself?
Question 9: Please justify the grade you would give yourself?
Question 10: Would you like to say something else, something that I didn't ask?