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

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INTRODUCTION

Welcome to the second issue of the sixth volume of the Journal of Problem Based Learning in Higher Education. Earlier this year, we published a Special Issue on "Integrating Academic and Artistic Methodologies within a PBL-environment", but the present volume is a regular issue with five research papers and six cases. We are proud of the two volumes in the seventh issue. Through the journal we wish to communicate both specific PBL research with a narrower focus through special issues as well as regular issues that provide a wider range of high quality research papers and cases from a variety of fields from the whole world. This volume therefore contributes to serve our overall vision of becoming a "global outlet for scholarship in problem-based learning in higher education". We also wish to have a more or less equal balance between research papers and cases to show both scholarly depth and disseminate experiences and sharing of good PBL practices. We find that both are important when providing access to research and practice related to PBL university pedagogy.

Below are two tables providing a rough overview of the five papers and six cases. For each of these, the country of the author(s) is mentioned along with a short statement of which education programme the paper or case was based on and finally the topic of the paper or case.

The five papers

Author country	Education programme	Topic
Brazil	Project management	Blended learning course evaluation
Costa Rica, Denmark	Informatics	Organisational culture
Canada	Zoology, biology	Student allocation to groups and assessment
Denmark	Social sciences and humanities	Student diversity in groups
Denmark	Information Studies	Critical thinking skills

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Table 1 shows that the five papers origin in different parts of the world, with around half more or less based in Denmark. The papers are both in natural and social sciences and in the humanities. The papers also deal with very different angles ranging from research on students' work in groups to the development of critical thinking skills and how different cultures or structures of a course affect the teaching and learning.

The six cases

Author country	**Education programme**	**Topic**
Kuwait, United Arab Emirates	Mechanical Engineering	Project about foldable laptop riser
Denmark	Rehabilitation Psychology	Master curriculum design
United Kingdom	Human Physiology	Critical thinking skills using Apps
Kuwait	Mechanical and Civil Engineering	Challenges working in teams
United States of America	Introduction to Design Foundations	Online reflection tool
United States of America	Computer Aided Drafting Technology	Assessment

Table 2 gives an overview of the six cases. Here we see an even wider geographical spread of authors, and an even wider spread of education programmes since several of the papers deal with engineering and health. Also the angles of the papers vary a lot and some deal with overall curriculum evaluation, others on concrete examples of using different types of digital tools in the teaching.

A few general traits become visible when doing such overviews. We see that several of the papers and cases are concerned with developing critical thinking in the students. Others are concerned with assessment of students and others with how students work in groups. The latter is strongly linked to PBL as it is a core aspect of PBL that students work together in groups. According to the theories underpinning PBL, this is something that aids the students in their learning. However, the number of papers concerning this, not only in this journal, also shows that how to implement this in practice is not a trivial question and more research is needed here. The fact that the issues of critical thinking and assessment are also present in many of the papers and cases is perhaps a reflection of critical thinking being considered a very essential element of higher education, but aiming for developing critical thinking in students, and actually achieving it, is also a difficult task. Similarly for assessment. PBL may have good answers here, but more research is still needed.

The editors are very pleased to learn that JPBLHE which origins at Aalborg University in Denmark, is by no means a "local" journal. It is indeed an international journal. This is something that we wish to maintain. We also see that JPBLHE has a good balance of papers and cases in all faculties. We want to be a journal that remains open to all faculties but this is really not something that the editors can decide for ourselves. We are dependent on researchers from all faculties, and all over the world, submitting good quality papers and cases. We hope that an issue such as the present one will continue to encourage researchers all over the world to keep sending us papers.

Finally, we should like to thank all the reviewers who have contributed to the improvement of the papers and cases in 2018:

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Lessons Learned Implementing Project-based Learning in a Multi-campus Blended Learning Environment

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ABSTRACT

In this article, we describe a project management course developed in a multi-campus, blended learning environment, with the participation of 14 NGOs. There were 70 undergraduate students involved, from three campuses of the Federal University of São Paulo, Brazil. We discuss how the course was conceptualized, provide an outline of its curriculum and online components, and analyze its successes and failures. To gather data, we used a convergent parallel mixed method approach, and we analyzed this data by means of a systemic analysis.

We found that working with real clients on real projects, in a multi-campus blended learning environment, increases the students' motivation to learn, develop skills, and complete projects. However, the occurrence of students dropping out of the course is demotivating and stressful to the remaining students and to the community partners.
We also found that the distances involved (between campuses and between campuses and NGO facilities), along with course schedule conflicts, make it difficult to establish rhythms between face-to-face activities and online activities. However, we also found that the intensive use of information technology can help overcome problems caused by distance and course schedule conflicts.

Keywords: Project-based learning, multi-campus, blended learning environment, community partners, project management.

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INTRODUCTION

The Federal University of Sao Paulo (Unifesp) was created in 1994 with only one campus, in Sao Paulo City. In 2004, a new campus was created in the city of Santos; in 2007 three new campuses followed, in the cities of Diadema, Guarulhos and São José dos Campos. In 2011 a sixth campus was created in the city of Osasco. Unifesp is now a large university, with approximately 10,000 students distributed across six campuses in six different cities (Appendix 1).

One of Unifesp's goals is to provide multi-campus courses in order to give their students the opportunity to study subjects from a variety of fields and promote integration among campuses. However, until 2015 there had been no multi-campus course offered. Then, on December 1, 2015, we received an email from the Undergraduate Dean asking if we were interested in participating in a pioneer project that would offer a web-based learning course to all the university campuses of Unifesp.

We proposed a project-based learning course to be called *Elaboration and Management of Projects.* We suggested that the course be not only web-based, but developed with blended learning characteristics. The students would learn project management theory by making use of the material on the course website: book chapters, video-lectures, and class notes. The students would be challenged, week-by-week, to put theory into practice and reflect on the learning process. They would do this by accomplishing a real-world project on behalf of a university community partner, under the guidance of the professors.

However, we had one important question: Would the course be offered as credit bearing, or as what we term an "optional" course?

After consultations with academic departments on the various campuses, we were told that that the course would have to be offered as non-credit, since the process of seeking approval for a new credit-bearing course on each campus would take a great deal of time. Although we saw the non-credit status as a possible barrier to student enrollment, we decided to go ahead with the project. First, we were excited about offering the opportunity to teach project management concepts to students from diverse fields. More importantly, we wanted to provide students with an opportunity to work on real projects, on behalf of NGOs that help people in need. We felt this would develop their interest not only in project management theory, but also in its application to the solution of social problems. We also wanted our course to foster a sense of citizenship.

At that point we were quite confident that we would be able to do this: we had had years of previous experience in conducting similar courses following the PBL approach (Arantes do Amaral & Gonçalves, 2015), and we had developed a reliable network of community partners (Arantes do Amaral, Gonçalves, & Hess, 2015). Throughout this time we had developed a sound methodology for conducting face-to-face PBL-centered project-management courses, with well-defined learning objectives for each class, clearly defined deliverables and milestones, and well-established discussion forums involving students, professors and community partners (Arantes do Amaral & Matsusaki, 2016). We knew exactly what the pitfalls were that could jeopardize a face-to-face PBL course (Arantes do Amaral & Okazaki, 2016), and we knew what to do and what to avoid (Arantes do Amaral & Frazão, 2016 ; Arantes do Amaral, 2017). However, we had no experience teaching such a course in a multi-campus, blended learning environment. We saw this as challenge and also as a research opportunity.

Our research questions thus became:

1. To what extent would working with real clients (community partners), performing real projects in a multi-campus blended learning environment, contribute to the learning of project management theory and development of project management skills?
2. What were the logistics and organizational challenges of providing such a course?

In this article, we present our findings related to these questions.

LITERATURE REVIEW

The design of our course supported our pedagogical philosophy of constructivism (Goodyear, 2005; Ryberg, Koottatep, Pengchai, & Dirckinck-Holmfeld, 2006), Constructivism can be understood as a theory, paradigm, or worldview that advocates learners' building their knowledge by constantly reflecting on the experiences accomplished (Clements & Batista, 1990; Perkins, 1991). These experiences can be very diverse, such as solving real-world problems or developing experiments. More than that, constructivism preaches that the learning should be student-centered rather than teacher-centered.

We decided to follow a project-based learning approach (PBL) as our high-level pedagogy. Project-based learning derives from constructivism (Hendry, Frommer, & Walker, 1999 Jonassen, 1999; Savery & Duffy, 1995) since it provides a methodology for teachers to empower the students, guiding the students to become active participants in their own learning process (Gijselaers, 1996; Tassinari, 1996). Project-based learning helps the learners to combine the theory studied in courses with practice (Lee, Blackwell, Drake, & Moran, 2014; Savery, 2006). Usually the students work cooperatively in small groups (Allen, Duch, & Groh,

1996), developing projects. *Projects* can be understood as temporary efforts undertaken to produce goods or services (Kerzner, 2013).

Researchers (Arantes do Amaral & Gonçalves, 2015; Larmer & Mergendoller, 2010) agree that academic projects should have a clearly defined scope, milestones, and deliverables, and that students should be required to follow a sequence of steps in order to create the product or service. In project-based learning, the students should be challenged to develop realistic and meaningful real-world projects (Bell, 2010). Researchers (Barron et al., 1998) point out that project-based learning can bring several educational benefits, such as the development of students' critical thinking and problem-solving abilities. Project-based learning has been used in science, technology, engineering and mathematics (thereafter STEM) education (Capraro & Slough, 2013). Some scholars (Tseng, Chang, Lou, & Chen, 2013; Verma, Dickerson, & McKinney, 2011) indicate that the combination of STEM and PBL (thereafter STEM PBL) may enhance the students' learning and motivation. In this regard, scholars (Capraro, Capraro, & Morgan, 2013; Markham, 2003) point out that professors have an important role, giving guidance to the teams of the students during the project, facilitating their learning, promoting reflection sessions and keeping the students focused on the creation of the product or service.

One way of giving students the opportunity to develop projects is by creating partnerships between universities and communities (Bouillion & Gomez, 2001). Although this may be challenging (Strier, 2011), scholars (Arantes do Amaral & Matsusaki, 2016; Arantes do Amaral & Frazão, 2016) report that PBL courses developed with the support of community partners may lead to the accomplishment of successful projects, bringing educational benefits to the students, research opportunities to the scholars and to the students (Arantes do Amaral & Lino dos Santos, 2018), and material benefits to the communities.

In this article, we describe a PBL course that involved the participation of community partners developed in a multi-campus, blended learning environment. Blended learning can be understood as an educational method that combines the traditional face-to-face instruction with computer-based instruction (Bonk & Graham, 2012; Garrison & Vaughan, 2008), making the best use of the benefits of each one (Osguthorpe & Graham, 2003; Vaughan, 2007). Blended learning can be accomplished in a variety of ways (Graham, 2006; Osguthorpe & Graham, 2003); the weight of the face-to-face and on-line activities in course design may vary, depending on the educational context and the information technology tools available for the course.

Blended learning can be facilitated by the use of different learning platforms (Steinø & Khalid 2017), including Moodle, Google+, Udemy, Rcampus, and Learnopia. Nowadays, the learning platforms can be accessed from computers, tablets or mobile devices (Smith, Lewi, Saniga, Stickells, & Constantinidis, 2017).

Blended learning may allow the use of different learning tools, such as pre-recorded video lectures, collaboration software, electronic forums, mixed reality, video games and simulations

(Singh, 2003; Kirkley & Kirkley 2005; Thorsteinsson, 2013). More than that, it can be accomplished in synchronous or asynchronous ways, or in a combination of both (Valiathan, 2002; Yamagata-Lynch, 2014).

Researchers (Donnelly, 2006; Giani & Martone, 1998) suggest that the use of PBL in blended learning environments may improve learning, since the on-line environment may make it easier for students to socialize, share ideas and knowledge, reflect together on the issues raised in face-to-face meetings, and contact the tutors/professors, receiving guidance and orientation.

Others researchers have investigated the use of PBL in multi-campus environments (Steedman, Smith, Keleher, & Martin, 2006; Mandal, 2008), indicating that it could be very challenging, requiring coordination of work across campuses and development of standard procedures to assure the quality of the courses offered.

However, there is still a lack of information about the challenges of using of PBL in a multi-campus, blended learning environment, involving the participation of community partners. This article aims to address this gap.

THE RESEARCH METHOD

We followed a convergent parallel mixed method approach (Creswell, 2013), collecting and analyzing quantitative and qualitative data in order to to have a better understanding of the problem we were studying. After that, we performed a systemic analysis, connecting the findings in a coherent way.

We gathered quantitative and qualitative data from questionnaires distributed at the end of the course, and from project documents: initial plans, team blogs, team reports, and emails. We gathered responses to the yes/no questions on the questionnaires, and to questions that asked students to respond to statements using the Likert scale.

We then analyzed this data statistically. We analyzed the qualitative data generated by the open-ended questions by selecting repeated words, phrases and statements and categorizing them as *recurrent themes* (RT). We discussed our analysis in detail in the Discussion section of this paper.

We analyzed the qualitative data following the five-phase analytic process proposed by Yin (2015): 1) compile the database, 2) disassemble the data, 3) reassemble the data, 4) interpret the result and 5) conclude. First, we compiled the qualitative database by gathering the data from questionnaires. Then, we disassembled the data, breaking it into single phrase fragments. After that we reassembled the data, grouping the correlated phrases into groups (recurrent themes).

In order to perform the fourth phase of the process (interpret the result) we made use of the results from our quantitative analysis and the recurrent themes from our qualitative analysis. We merged the two by means of a systemic analysis, combining the information we gathered from both analyses with the information we obtained from project documents. Based on this interpretation we came to our conclusions. Figure 1 presents an overview of the research method we followed in our case study.

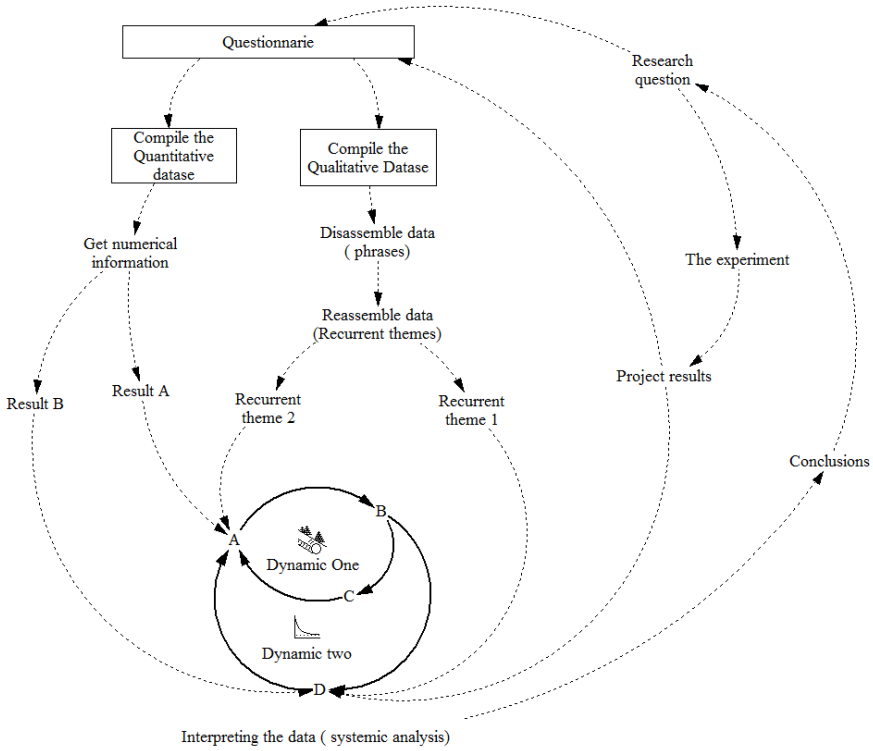

Figure 1. The research method used in our case study (adapted from Yin (2015, p. 186))

Participants

There were 70 undergraduate students involved, from three campuses -- Guarulhos, Baixada Santista, and Diadema. The students were from all semesters of the undergraduate courses, in the fields of Social Work, Environmental Sciences, Languages, Sciences, Chemistry, Industrial Chemistry, Chemical Engineering, Petroleum Engineering, Environmental Engineering, Ocean Sciences, Nutrition, Physiotherapy, Philosophy, History of Art, Social Sciences, and Pedagogy. There were two professors involved and one research assistant. The first professor designed the course and research model and taught the course. He also was the responsible for creating this article. The second professor and the research assistant helped to analyze the data, and made comments and suggestions for the research article.

Instruments and procedures

We collected data from questionnaires sent to the student teams at the end of the project, and from the project documents: plans the teams created, notes they made regarding the project development, and the products and services they created.

We also collected data from the project blogs: each team developed a blog, where they described the work they had accomplished each week.

The questionnaires had two classes of questions: nine closed-ended questions (used to collect the numerical data) and fifteen open-ended questions (used to collect the qualitative data).
The first 6 questions were about the learning environment. The remaining 3 were about the project.

Questions about the learning environment

The first two structured questions were:

1. Did you read the suggested articles?
2. Did you watch the video-lectures?

We allowed the students to choose one of the following options:

() Yes, we read/watched all. () No, we did not read/watch any. () Yes, we read/watched some.

We designed these questions because we wanted to know if the students were making use of the material we created specifically for this course.

In the next four questions, we used the Likert scale, asking students to agree or disagree with the following statements:

1. The readings were useful to your learning.
2. The video-lectures were useful to your learning.
3. The face-to-face meetings were useful to your learning.
4. The on-line quizzes were useful to your learning.

( ) Strongly agree ( )Agree ( ) Neutral ( ) Disagree ( ) Strongly disagree

We designed these questions because we wanted to ascertain the usefulness of the material we created for the course (the video-lectures, readings and on-line quizzes). We also wanted to know if the face-to-face meetings contributed to the students' learning.

Questions about the projects

The final three statements were about the projects themselves:

1. Working on a real project on behalf of real clients was motivating.
2. Working in groups facilitated learning.
3. The project blogs were a useful source of information.

We again used the Likert scale, asking the students choose one of the following options:

( ) Strongly agree ( )Agree ( ) Neutral ( ) Disagree ( ) Strongly disagree

We designed these questions because we wanted to know the students' perceptions in regard to the motivation of working on a real project. We also wanted to know if working in teams facilitated their learning and if the project blogs were a useful way of promoting knowledge sharing.

The sixteen open-ended questions were the following:

1. What was the NGO your team chose? What motivated that choice?
2. What was the project´s scope?
3. What were the team members' roles and responsibilities?
4. Did your project involve fundraising activities? If so, what strategy did your team use to raise them?
5. What were the main problems your team faced during the project? How did you solve these problems?
6. What were the lessons your team learned by working on a project?
7. How did you manage conflicts?
8. What would you do differently, if you did the same project again?
9. Tell me what have you learned by working on a real project, with real clients. Tell me how you applied the project management techniques you learned in our theoretical classes.
10. What advice would you give to the students taking the course next semester?
11. How many hours did your team spend on average during each week of the project?
12. Describe your relationship with your project client (the NGO).
13. Did you deliver the product (or service created) on time? If not, what caused the delays?
14. What else would your team like to report?
15. Please attach the NGO´s evaluation of your project.
16. Insert pictures of your team, of the team meetings with the NGO´s representatives, and the product or the service created.

We designed these questions to obtain an overall picture of the project: what motivated students, what problems they faced and how they resolved them, whether the project was successful in delivering its service or product, and how the community partner NGOs felt about the experience.

Concept and design of the course

We created an educational setting in order to take the advantage of our high-level pedagogy in a practical way (Goodyear, 2005; Ryberg, Koottatep, Pengchai, & Dirckinck-Holmfeld, 2006). It would allow the students to actively learn by doing, guided by us and with support of community partners, making the best use of on-line and face-to-face learning opportunities (Osguthorpe & Graham, 2003; Vaughan, 2007).

We proposed a course that would follow a project-based learning (thereafter PBL) approach. The students would work in teams of five, developing real-world projects. The goal of the course was to teach project management concepts, and challenge the students to apply these concepts in practice in a real-world project, working with a real client (the community partners). The students would be free to form their teams. The teams could be formed by the students of same campus (single campus team) or by students from different campuses (multi-campus team). The teams should develop a project on behalf of one NGO, chosen by them from a list of 14 NGOs (Appendix 2).

In our course, the NGOs would play the role of the clients. They would offer the students a set of project themes based on their needs. For example, the NGOs might ask the students to acquire food, clothes, medicines, school materials, and so on.

The NGOs would send the professor a list of project themes. The professor then would analyze each theme proposed by the NGOs, paying attention in its feasibility and adequacy for the course and then revising the list. After that, the professor would put the reviewed list onto the course website and would request the students to choose one theme.

After choosing the theme, the students would contact the NGO to schedule a visit during which they would interview an NGO representative. Once they understood the NGO's needs, they would be able to define the project´s scope. After that, the students would define their roles and responsibilities. For example, one student would be the project manager, another would be the fundraising manager, and another would be the communications manager and so on so.

Each team would develop a project blog. This blog would assemble all information about the project: the theme chosen, the team members' names, roles and responsibilities, the fundraising strategies followed, the project´s plans, the problems the students faced and the solutions developed to deal with them, the project development week-by-week, and the lessons learned. The project blog had three main purposes: first, to foster students' critical thinking and

reflection; second, to allow the professor to follow the development of each project week-by-week; and third, to allow the students to follow the other projects. The blog was conceived as a discussion forum, allowing the professor to discuss the assignments with each team, clarify issues, and give guidance. The blog also promoted knowledge sharing, since all students could follow all the projects, week by week.

We also planned to have four face-to-face meetings, each three hours long. The first meeting, held the first week, would involve the professors, the students and the community partners. The second and third meetings (at five and ten weeks, respectively) would involve only the students and professors. The final meeting, in the fifteenth week, would involve the professors again, the students, and the community partners. The first meeting had the objective of giving the students information about the course, the clients (the NGOs) and the project themes. It also had the objective of giving the opportunity to the students get to know each other and form teams. The second meeting had the purpose of letting the students show the professor how the groups were organized and how the initial tasks were developed. It also had the purpose of informing the students about each team's project and provided the students the opportunity to interact with the professors. The third meeting had the purpose of giving the professor feedback about each project's development, about the problems the students were facing and the solutions they were working on. It also had the purpose of promoting reflection about the learning process and knowledge sharing. The fourth meeting had the purpose of closing the project; the students would present the results and the lessons they learned. It also had the objective of promoting a reflection about the entire experience, letting the student receive feedback about the projects from the professors and from the community partners. This final meeting had the purpose of promoting reflection not only on the project achievements, but also on the learning process itself.

Throughout the course, we planned to give guidance and feedback to the students in two different ways. The first was by weekly emails. The emails would have the objective of providing general guidance and information about how the projects were developing. We planned to use these emails to remind the students about their weekly assignments, to give feedback about the status of all the projects, to answer questions raised by individuals that would be of interest of all, and to give information about the learning material added. In this email, we planned to ask the students to remember to update their blogs, posting problems they were facing and any questions they might have. We also planned to use this email to let the students know about the updates of the FAQ (Frequently Asked Questions) section of the course website, where we planned to answer questions raised by the students.

The second means of communication was through project blogs. We planned to access each blog daily, reading the blog content and writing comments whenever necessary.

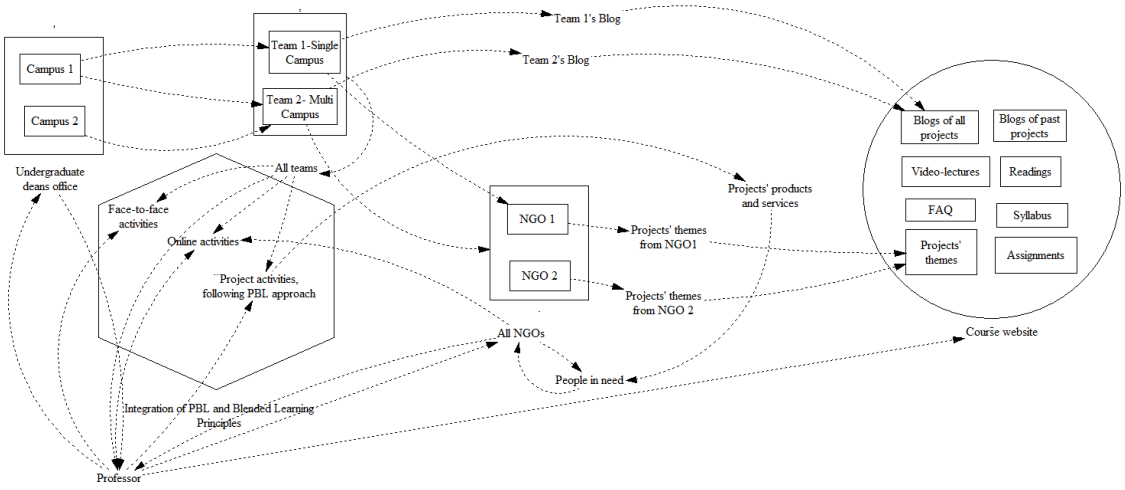

Figure 2. An overview of the course conception (In the interests of brevity, we represent only 2 campuses in this figure).

The development of the on-line learning environment

In January 2016 we spent one week analyzing, testing and comparing different virtual learning environments and course management systems such as Blackboard Learn©, Moodle©, Google for Education© and Google Sites©. After the evaluation of each of these tools we decided to create our website using Google Sites©.

We used Google Sites© for two reasons: first, this tool was very easy to use and very powerful. We could create the course website rapidly, and we knew we would be able to create pages for videos, articles, discussion forums and many other resources. Second, the tool was free.
In the beginning, we were not sure how much information to post on the course website. In search of inspiration, we studied the MIT Open Courseware environment, seeing how the courses were organized and how their websites were structured. Based on this analysis, we decided that our course website would contain the following information:

1. The course overview.
2. The syllabus (general information, the course objectives and scope, the course materials, the grading rules, the course calendar).
3. The week-by-week plan (each week had a specific page that included learning objectives, course readings, video lectures, project activities and assignments).
4. The project themes.
5. The links to the blogs of the students' projects.
6. Information about the NGOs.
7. Information about past academic projects.
8. Frequently asked questions.

Our idea was to create a very detailed website that would contain information about the course, the projects, and the NGOs, and would make clear to all teams what they were supposed to do in each week of the project. The main page of our course website had the structure presented in Figure 3.

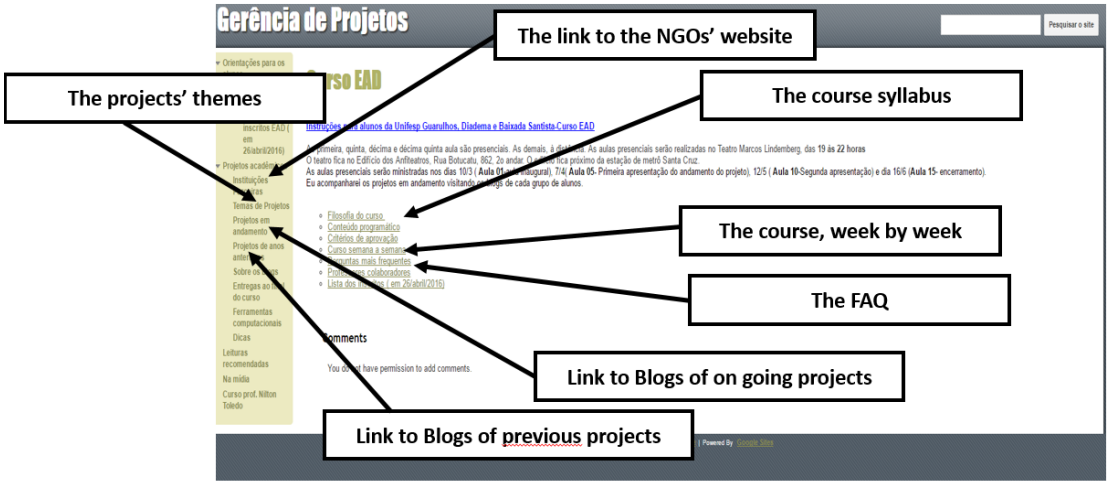

Figure 3. The main page of the course website.

In January, while planning the course, we sent email to the NGOs, informing them about this new course, explaining the difference between this course and traditional face-to-face courses, and asking them for their support to the students. We also asked them to send us possible project themes. We received 102 replies.

During the beginning of February, we developed the week-by-week course plan (Appendix 3). Each week had a learning objective, project activities and assignments. Based on the planning we created 15 webpages, one page for each week of the project (Figure 4).

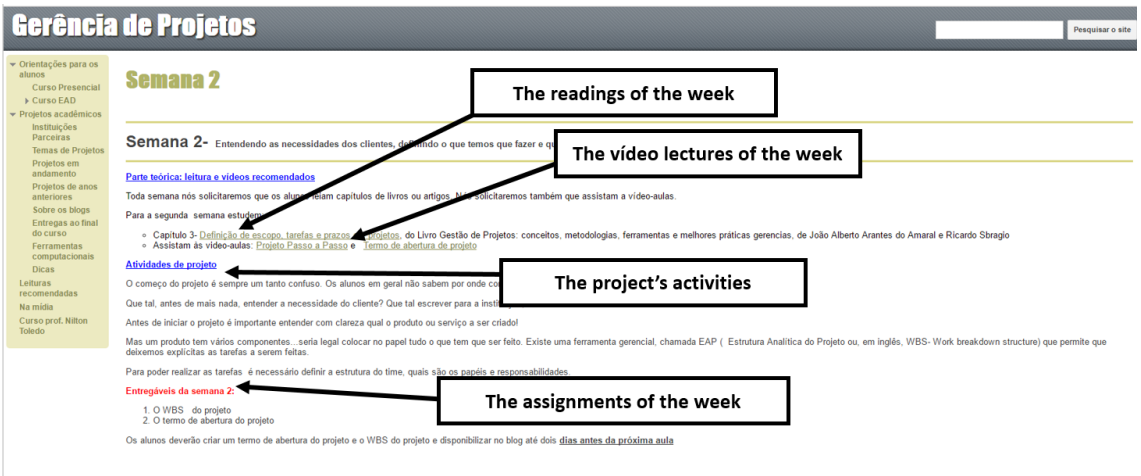

Figure 4. An example a page created for each project´s week.

The course development

The course was planned to begin on March 10. Out of the six campuses, three (Diadema, Guarulhos and Baixada Santista) offered our course to their students.

Two weeks before the course began, on February 23, we sent an email to all enrolled students, welcoming them and providing information about the course schedule and website.

We told the students that the course would follow a project-based learning approach and that they would work in teams on real projects. We informed them that the course would be very challenging: they would learn project management theories and apply them to real-life projects. The projects would be on behalf of 14 organizations working with people in vulnerable conditions. We let the students know that during the course we would have four face-to-face meetings, the first one scheduled on the first day of the course, March 10. Students were informed that this meeting would take place in the auditorium of the campus in São Paulo. We also asked the students to watch 3 short videos describing the course philosophy and reporting on previous projects.

We let the students know that this first face-to-face meeting was very important: it was an ideal opportunity to form project teams and to ask us questions about the course.

The first meeting occurred on the date planned: however, only 50 out of the 70 enrolled students attended. At that time, we thought that the main reason for the low turnout was the heavy rain that fell that day: there was a good deal of flooding, and Sao Paulo city was paralyzed. Some students let us know by email that they would not be able to attend this meeting due to the fact that they lived in other cities and didn't have resources to afford the travelling costs.

Nevertheless, we went ahead and talked to those who were able to attend about the challenges involved in real-life projects. The NGO representatives presented their institutions and their needs. During this first meeting, we encouraged the students to talk to each other in order to form the project teams. Almost all groups were formed during this meeting.

After the meeting, we sent an email to all 70 students who had enrolled in the course, with their contact information (email), letting them know what had occurred in the first meeting. We wanted the students who had not attended the first meeting to use the list in order to get in touch with others to join project teams.

In the following week, the Guarulhos campus went on strike: this event created several problems. Several students sent us emails, asking if we were going to delay our course. We let them know that we were going to follow the course as planned. Some of students from Guarulhos then decided to drop the course.

In each of the following weeks we sent an email to all students, reminding them about the weekly assignments and giving them feedback on the status of their projects. This worked very well: the students acknowledged that this kind of action was very helpful, since they were often so busy doing assignments for other face-to-face courses that they sometimes forgot about our course assignments.

Every day, we followed the students' blogs, paying attention to the problems they reported and contacting each team whenever it was necessary, giving guidance and suggestions. We also answered the questions the students had by email and updated the FAQ section of the course website. The students let us know that they appreciated receiving this kind of attention. Some stated that they did not have this kind of consideration in many of the regular face-to-face courses they attended.

We began the course with 70 students, divided in 14 teams of five students. During the course, 33 students dropped out (dropout rate of 47%). Each time a student dropped out, the students of the affected group sent us an email, asking for our assistance in finding some other student to replace the one who had dropped out. We spent a substantial amount of time (approximately three hours per week) answering the students' questions and solving problems related to the dropout issue. This was stressful and demotivating for both professors and students.

Furthermore, we were able to hold only three of the four planned face-to-face meetings. Attendance was good only at the first meeting (50 students attending), since the regular courses hadn't begun as yet. As the week passed, the teams sent us emails, warning us that many of the team members would not be able to attend our following meetings because of schedule conflicts with regular credit-bearing courses held at their campuses. However, they let us know that they would make efforts to send at least one team member to attend the meetings in order to receive guidance and orientation. The attendance dropped in meetings two (6 students attending) and three (2 students attending), and as the course approached to the end, the problem grew larger. We had to cancel the final meeting because students let us know that they had to attend exams in their regular courses on their campuses; thus, they were not able to send any team member to our final meeting.

Only 37 students finished the course, delivering 9 projects. We considered the project a success if it met two criteria:

1. The project reports and documents showed clear evidence that the students were able to create the product or service that they had chosen to create and the NGO representative's evaluation confirmed the evidence presented in the students' reports.
2. The plans and managerial documents created (such as the Project Charter, the Project's Work Breakdown Structure (WBS), Project network of activities, Risk

Management Plan, Communication Plan, Fundraising Strategies) were carefully completed, demonstrating that the students had understood the concepts presented in the video-lectures and readings.

We considered the project a partial success if it met only the second criteria. We considered the project a failure if the students failed to address both criteria. From nine projects, six were classified as successful, two as partial successes and one as a failure (Appendix four).

THE RESULTS

In this section, we will present the students' answers to the structured questions, the results of each project, and the recurrent themes that emerged from the analysis of the open-ended questions.

Results of Quantitative Data: The answers to the structured questions

Questions	Yes, we read/watch all	No, we did not read/watch any	Yes, we did some
Did you do the suggested readings?	33%	0	67%
Did you watch the video-lectures?	44%	0	56%

Table 1. The students' answers about their efforts to do the readings and watch the videos.

Questions	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The readings were useful to your learning	44%	44%	0	0	12%
The video-lectures were useful to your learning	44%	44%	0	0	12%
The face-to-face meetings were useful to your learning	11%	11%	78%	0	0
The on-line quizzes were useful to your learning	11%	56%	11%	0	22%

Table 2. The students' answers about the usefulness of the course readings, the video-lectures, the on-line quizzes and the face-to-face meetings.

The quantitative data revealed that the majority of the students made use of and learned from the readings (Table 1, line 1 and Table 2, line 1), from the video-lectures (Table 1, line 2 and Table 2, line 2) and from on-line quizzes (Table 2, line 4).

Question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Working on a real project on behalf of real clients was motivating	78%	11%	0	0	11%
Working in groups facilitated the learning	56%	44%	0	0	0
The project blogs were a useful source of information	56%	44%	0	0	0

Table 3. The team's answers about the project

The data also revealed that the majority of the students acknowledged that working on a real problem was motivating (Table 3, line 1) and that the team´s activity fostered their learning (Table 3, line 2). The data also revealed that the project blogs allowed knowledge sharing (Table 3, line 3). Therefore, we may conclude that the on-line learning environment was indeed effective.

Results of Qualitative Data: The recurrent themes that emerged from the open-ended questions, after applying the five-phase analytic process

Eight recurrent themes (RT) emerged.

RT 1: Developing a project for a real client that helps people in need was motivating
Reading the team reports, it was clear the students valued the fact that they were developing a project on behalf of a real client. One group pointed out:

> "Helping the IFH (Institute Future´s Heirs) was an enlightening experience: with our project, we were able not only to learn project management theory but also help people in need."

The students also let us know that working with a real client encouraged the team to work in a more responsible manner. One group explained:

> "Having a real client brought us an additional sense of responsibility, made us take the course more seriously. We did not expect that this course would bring such a real-life experience. The course was very impressive to us."

Having a real client motivated them to work harder and better, as one group described:

> "Working with a real client improved our motivation; we worked very hard in order to fulfill the client´s expectations, delivering a high-quality product. We knew that the people that we were helping had expectations about our work."

RT 2: Developing a real project fostered learning

Analyzing the teams' answers, we saw that working on a real-life project improved the students' learning. One group remarked that the course proposal surprised them:

> "At the beginning we felt intimidated by the course proposal, which stated we would be learning the concepts and putting them into practice right away. However, it was an excellent experience, and we will use what we have learned in our lives and in our future projects."

Another group stressed the challenges of working in groups, in a distributive and collaborative environment:

> "We learned several lessons. One lesson was how to work collaboratively, by distance, with colleagues from other campuses and cities. It was very challenging. The learning of project management techniques helped us to manage the project effectively."

Finally, a third group pointed to the benefits of learning by putting theory into practice:

> "In theoretical courses sometimes we are not able to see the complexity of the processes that are present in real life. In this real-life project, we realized how much effort is needed to carry on fundraising strategies, for example. In addition to that, we can say that in real projects sometimes the strategies do not work the way the theory describes that they should."

RT 3: Dropouts caused problems for the projects

Almost all teams faced problems due to the number of dropouts. One group explained the problems they faced:

> "One team member left the course in the middle of the semester. We had to split his activities among the other team members. This student was the person responsible for our project´s blog. When he left, we faced difficulties in dealing with the unfinished work he left to us."

RT 4: The students made intensive use of software communication tools and social networks websites to manage the project

The students let us know that they relied on technology in order to promote virtual meetings and to share project documents. One group said:

> "We created two groups, one on Facebook and other on WhatsApp. Doing so we were able to inform each other about the status of the project's activities and to talk about the project´s deliverables."

RT 5: The students faced problems meeting with the clients because of the distances involved

One important aspect of project-based learning courses is to promote meetings between the project teams and their clients. However, in this course many of the students did not live in the same city where their clients worked. This proved a problem. One group made this point clear:

> "It was not possible to have a face-to-face meeting with our client, due to the fact that we live in a different city and we did not have resources to pay for the travelling expenses."

RT 6: The students had difficulties scheduling face-to-face meetings with team members

In addition to the difficulties the students had in meeting with clients, they also had trouble scheduling meetings with each other – even when all students were studying at the same campus. One team explained:

> "It was difficult to have time to meet: some students attend classes during the day, others at night."

RT 7: The students' commitment to the project is key to the project´s success

Almost all teams that succeeded in their projects pointed to the fact that the commitment of the members was one of the reasons for their success. One group stated:

> "The project will be successful only if the team members are 100% committed to the project."

RT 8: The student dropouts demotivated the community partners (the NGOs)

The NGO´s emails evaluating the projects pointed to that the fact that students' dropping out was very demotivating to the community partners. One NGO representative told us:

> "One student's group had a meeting with us. We became very excited about the project; we had hopes and expectations. However, the group never came again, we do not know what happened to them. It was very frustrating…"

DISCUSSION

So, what did we learn from this experience?

Coming back to our first research question, we will discuss now whether the challenge of making the students work with real clients (community partners) and performing real projects in multi-campus distance learning environment, contributed to their learning of project management theory and development of project management skills.

The data revealed (Appendix four) that the majority of the teams (six out of the nine teams) were able to put the project management theory in practice, developing the project plans and executing them, creating the products or services. The data also revealed that two teams had partial success; they were able to create the project plans but failed to put the plans into practice, therefore failing to create the products or services they had aimed to create. Only one team failed in creating and executing the plans.

The recurrent themes RT1 ('Developing a project for a real client that helps people in need was motivating'), RT2 (´Developing a real project foster the learning´) and RT 7 ('The students' commitment to the project is key to the project´s success') that emerged from the qualitative data reinforce the previous quantitative data.

However, the dropout rate was fairly high (47%), and the qualitative data suggests (RT3 'Dropouts caused problems for the projects' and RT8 'The student dropouts demotivated the community partners') that the dropout issue increased student stress and demotivated the community partners.

Therefore, this analysis led us to our first finding:

Finding #1: Working with real clients on real projects, in a multi-campus blended learning environment, increases the students' motivation to learn, develop their skills, and complete the projects. However, the dropout issue may bring stress to students and demotivation to the community partners.

This finding is aligned with the similar findings of researchers who studied PBL courses in context involving students and NGOs (Arantes do Amaral & Gonçalves, 2015; Arantes do Amaral & Matsusaki, 2016; Arantes do Amaral, 2017).

Coming back now to our second research question, we will discuss our findings about the logistics and organizational challenges of providing multi-campuses course PBL course, in a blended learning environment involving community partners.

The distances between the campus from where the students attended the courses and the campus where the face-to-face meetings were held posed a problem for some students (Distance from Sao Paulo campus: Guarulhos 22 Km, Baixada Santista 80 Km, Diadema 22 Km). The number of students who attended the face-to-face meetings with the professors dropped as the course went on (Meeting 1: 56 students, Meeting 2: 6 students, Meeting 3: 2 students).

The data also revealed (Appendix four, column 2) that in three of the nine projects, the teams of students were from different campuses and different undergraduate majors. The data also revealed (Appendix four, column 2) that even when the students belonged to the same campus (that was the case in three of the six remaining projects) the students were from different undergraduate majors. We may consider that being enrolled in different major courses may have made it difficult for students to meet each other. The qualitative data (RT6 'The students had difficulties scheduling face-to-face meetings with the team members') reinforces this.

Therefore, we may conclude that distances involved and the schedule conflicts made difficult for the students to perform face-to-face activities with their peers and with the professors.
What about the face-to-face meetings with the clients?

The qualitative data (RT5 'The students faced problems meeting with the clients because of the distances involved') revealed that distance from the cities where the students studied and the city where the NGOs were located (São Paulo) also posed communication problems between the students and the NGOs.

The previous analysis led us to our second finding:

Finding #2: The distances involved (between campuses and between campuses and NGO facilities), along with course schedule conflicts, bring difficulties in establishing rhythms between face-to-face activities and online activities.

This finding is aligned with the findings of researchers (Steedman, Smith, Keleher, & Martin, 2006; Mandal, 2008) that have studied multi-campus, PBL-centered courses.
However, the qualitative data also revealed (RT 4 'The students made intensive use of software communication tools and social networks websites to manage the project') that the students used information technology tools in order to overcome the problems caused by the distances and to reconcile the different agendas. This led us to our third finding:

Finding #3: Intensive use of information of technology can help overcome the problems caused by distance and course schedule conflicts.

Connecting all our findings in a systemic perspective (Figure 5), we may say that providing PBL course, in a multi-campus blended learning environment, with support of community partners can be very challenging.

On the one hand, having the students work in real-life projects stimulates them to be proactive, to find solutions to the problems they face. In so doing, they learn more and develop their project management skills (Figure 5, feedback loop 'Developing project management skills'). More than that, the students feel good about their projects' achievements, which in turn raises their motivation and commitment to the course. The more motivated the students become, the more they use the online course´s materials (Figure 5, feedback loop 'Utilization of the course materials'), which in turn increase the development of their project management skills. Besides the educational benefits the projects bring to the students, the projects also bring benefits to the community partners and the larger community (Figure 5, feedback loop 'Bringing benefits to the communities').

On the other hand, we saw that the distance between the campuses and the scheduling conflicts may jeopardize the attendance at face-to-face course meetings, which may impact negatively on the students' learning (Figure 5, feedback loop 'Face-to-face guidance'). More than that, the absence of face-to-face meetings between the students and the community partners may bring problems in the students' understanding of the scope of the projects, which can harm the development of the projects. In addition to that, students' dropping out of the course also brings problems not only to the students who remain (Figure 5, feedback loop 'Dropouts problems') but demotivates the community partners (Figure 5, feedback loop 'Impacting the partnership'). However, the intensive use of information technologies tools may help the students to overcome these problems (Figure 5, feedback loop 'Virtual meetings').

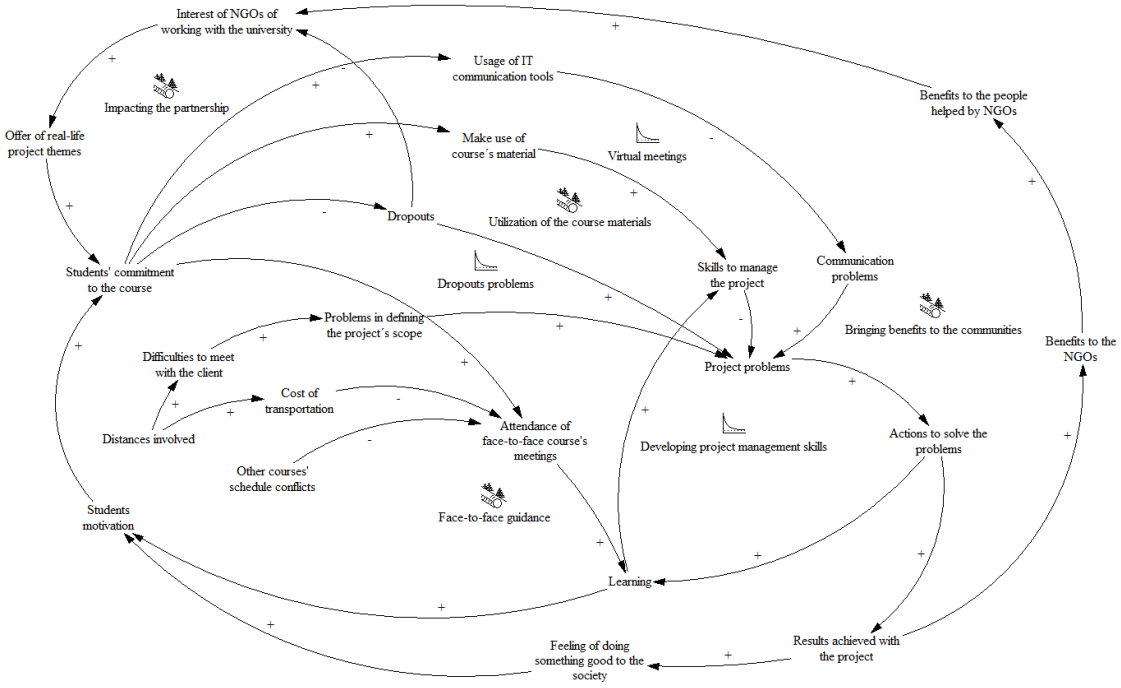

Figure 5. The course dynamics

Concluding, we may say that our course design didn´t work exactly the way we thought it would. The on-line material was regularly accessed; however, the face-to-face activities didn´t work the way we planned. Nonetheless, the intense use of information technologies tools helped to ameliorate this problem.

What could we have done differently? What could we do in the next course to address some of the problems described in this paper?

- Offer the course as credit bearing so as to limit the number of dropouts. We conjecture that if the course was credit bearing, the students' commitment to it would be greater and the number of students dropping out would be smaller. The high number of dropouts was problematic in a course such as ours, where team consistency was vital to the success of each project.
- Improve coordination among campuses. Coordinate the course schedule so that there are a minimum number of conflicts. Since the course is designed as blended, -- and thus not fully online,-- we speculate that an overall multi-campus course schedule would allow professors to reserve dates for face-to-face meetings that would not conflict with dates for other courses. The overall multi-campus schedule would also help avoid problems arising from unexpected changes in the schedules on individual campuses.
- Ask the university to provide better transportation options for students. If the university could provide a shuttle bus, for example, face-to-face meetings could be planned at times when students would be able to attend them. This could be done

in the context of a wider effort to schedule the courses at times when there would be fewer conflicts (see above).

- Obtain technical support from the university. We speculate that if the university had designated a member of its IT staff to work with us, the communication and collaboration between all parties would have been easier.

However, despite all the problems we faced, based on the evidence here presented, we argue that this experience brought benefits to all participants: to the students, who were able to learn project management concepts by means of real-life projects; to the NGOs, who received products and services that helped them to perform their work; to the professors and Unifesp, who learned important lessons that can be applied in future multi-campus courses; and finally to the broader community, who received help from the NGOs. We hope that the lessons learned from our experience can be helpful to scholars who wish to undertake similar educational projects.

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Appendix 1-The six Unifesp campuses and the undergraduate courses offered.

Campus	Courses offered
Unifesp São Paulo	Medicine, Nursery, Biology, Speech Therapy, Health Technologies
Unifesp Osasco	Economy, Accounting Sciences, Actuarial Sciences, International Relations and Administration
Unifesp São José dos Campos	Computer Science, Mathematics and Engineering
Unifesp Guarulhos	Social Sciences, Language Studies, History, Philosophy, Pedagogy
Unifesp Baixada Santista	Physical Education, Environmental Engineering, Ocean Science and Technology, Social Service, Occupational Therapy, Nutrition
Unifesp Diadema	Pharmaceutics, Chemistry and Chemistry Engineering

Appendix 2-The NGOs

Institution name	**Institution field of work**
Casa Assistencial Amor e Esperança - **CAAE** (Assistencial House Love and Hope)	Gives support to children with cancer and non-contagious diseases.
Instituto Herdeiro do Futuro-**IHF** (Institute Future´s Heirs)	Gives psychological assistance to children who have been victims of sexual abuse.
Instituto Fazendo História-**IFH** (Institute Making History)	Gives assistance to orphanages.
Comunidade de Impacto-**CI** (Impact Community)	Provides free educational opportunities to children from poor families.
Grupo Luz-**GL** (Light group)	Gives support to elders from poor families.
Assistência Vila Mascote- **AVM** (Care Group Mascote´ Village)	Gives support to elders with mental problems.
Casa do Pequeno Cidadão-**CPC** (Home of the little citizens)	Gives support to children who are victims of parents' negligence or abandonment.
Associação Grupo Ação de Assistência, Promoção e Integração Social-**GAAPIS** (Social Assistance, Development and Social Integration Association)	Provides free educational opportunities to teenagers from poor families.
Associação Solidariedade e Esperança Claretinos-**ASES** (Hope and Solidarity Claretianos)	Provides free educational opportunities to children and teenagers from poor families.
Lar São José-**LSJ** (Saint Joseph Home)	Nursery home that provides educational opportunities to children from poor families.
Toca do Estudante- **TE** (Students' Den)	Provides assistance and shelter to students from poor families.
Associação Nipo-Brasileira- **ANP** (Japanese-Brazilian Association)	Provides free educational opportunities to children and teenagers from poor families.
Associação Cristã Caminhos da Verdade-**ACCV** (Christian Association Paths to the Truth)	Provides free educational opportunities to children and teenagers and elders from poor families.
Unidade de Reabilitação de Deficientes Visuais-**URDV** (Vision rehabilitation unit)	Provides assistance to people with blindness and severe sight problems.

Appendix 3- The week-by-week course planning

Week	Week objective
1	General objective: Give the students information about the course, the clients (the NGOs) and the projects themes. Give the opportunity to the students get to know each other and form teams. Learning objectives - the students should learn: The concepts of project and project management The life cycle of a project The phases of a project Project activities - the students should perform the following activities: Assemble a project team Choose the client and theme Create a project blog Watch the videos lectures and readings for the week Answer the questions on the evaluation form Assignments: The students should email the professor the names of the client and the project, the names of the team members, and a link to the project blog.
2	Learning objectives -- the students should learn: How to define the scope of a project How to create a project charter How to structure the work breakdown on a project Project activities - the students should perform the following activities: Contact the client and schedule a visit Plan the visit Watch the videos lectures and readings for the week Assignments- the students should post on the project blog: The project charter The project's work breakdown structure (WBS)
3	Learning objectives - the students should learn: How to develop fundraising strategies for the project How to create a project network of activities (using the critical path method) Project activities - the students should perform the following activities: Visit the client Update the blog to include the project charter and the work breakdown structure (WBS) Watch the videos lectures and readings for the week Assignments - the students should create: The fundraising strategy for the project The network of activities for the project
4	The students should prepare the first project status report. Learning objectives - the students should learn: How to create a status report Project activities - the students should perform the following activities: Create a status report Watch the videos lectures and readings for the week The project manager of each team must post the project status report on the project blog

5	Learning objectives - the students should learn: To identify project risks How to create a risk analysis Project activities- the students should perform the following activities: Create risk management plan Watch the videos lectures and readings for the week The project manager of each team must post the risk management plan on the project blog. Special task The students should present the status report to the professor during a face-to-face meeting
6	Learning objectives - the students should learn: To set up a plan for how and how often team members would communicate with each other and with the client Project´s activities- the students should perform the following activities: Create a project communication plan Watch the videos lectures and readings for the week The project manager of each team must post the project´s communication plan on the project blog
7	Learning objectives - the students should learn: The systemic aspects of the projects: the interconnections and interdependencies between the activities. The systemic impacts of the project manager's decisions How to catalog the lessons learned in a project Project´s activities- the students should perform the following activities: Creation of project *lessons learned* catalog Watch the videos lectures and readings for the week The project manager of each team must post the lessons learned catalog on the project blog:
8	Learning objectives- the students should learn: How to measure the quality of a project Quality planning, quality control and quality assurance Project activities- the students should perform the following activities: Create a project quality management plan Watch the videos lectures and readings for the week The project manager of each team must post the quality management plan on the project blog.
9	The students should prepare the second status report on the project. Learning objectives- the students should learn: How to make a better project status report Project activities- the students should perform the following activities: Improve the project status report Watch the videos lectures and readings for the week Post on the project´s blog the second status report on the project
10	Learning objectives- the students should learn: How to create a final project report Project activities- the students should perform the following activities: Create a draft of the final project report Watch the videos lectures and readings for the week

	Post the draft of the final project report on the project blog. Special task The students should present the second status report to the professor during a face-to-face meeting
11	Learning objectives- the students should learn: The earned value analysis (EVA) technique To become familiar with the EVA's indexes Project activities- the students should perform the following activities: Apply EVA to the project Watch the videos lectures and readings for the week Post the project´s EVA indexes on the project blog.
12	Learning objectives- the students should learn: The concept of conflict as it applies to project management Conflict development and conflict mitigation strategies Project activities- the students should perform the following activities: Reflect on the conflicts they have faced during the project. Watch the videos lectures and readings for the week Post a description of the conflicts they have faced and how they have managed them on the project blog.
13 and 14	During these two weeks the students should review the blog and finalize the project activities. The students should also work on the final project report and review the project documents.
15	Course wrap-up. The students should send the final reports and present the final status report to the professor during a face-to-face meeting.

Appendix Four-The projects accomplished and the results

Group number	Students' background	NGO	Project´s scope	Project's Documents	Creation of Product or service	Success or failure
1	Five students in the field of Social Work from Baixada Santista Campus	**IFH**	Acquire school supplies	Well documented	Created	Success
2	Five students from 4 different fields (Environmental Sciences, Languages, Sciences and Chemistry) from 3 Campuses (Baixada Santista, Diadema and Guarulhos)	**IFH**	Create Portuguese subtitles to a documentary	Well documented	Created	Success
3	Four students from Industrial Chemistry and Chemical Engineering	**IFH**	Acquire 200 books for children	Well documented	Created	Success

	fields from Diadema Campus					
4	Four students from Petroleum Engineering, Environmental Engineering and Ocean Science from Baixada Santista Campus	**URDV**	Repair the water supply systems at the NGO's location	Well documented	Created	Success
5	Four students from 3 different fields (Nutrition, Physiotherapy and Philosophy) from 2 Campuses (Baixada Santista and Guarulhos)	**CI**	Obtain clothing donations for the NGO´s bazaar	Well documented	Created	Success
6	Three students of History of Art, Social Sciences and Pedagogy fields from Guarulhos Campus	**ASES**	Develop five educational workshops for the children helped by the NGO	Well documented	Created	Success
7	Four students in the field of Social Work from Baixada Santista Campus	**ASES**	Obtain resources to print NGO material	Not well documented	Not created	Failure
8	Three students in the field of Philosophy from Diadema Campus	**ACCV**	Recruit volunteers to work with the NGO	Well documented	Not created	Partial success
9	Five students from Environmental Sciences, Philosophy and Sciences from Diadema and Guarulhos Campus	**ACCV**	Acquire food and hygiene supplies for a leprosarium	Well documented	Not created	Partial success

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How Does Organisational Culture Influence the Process of Change Towards PBL?

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ABSTRACT

With the growing demand to use pedagogical approaches to foster 21st-century skills such as problem solving, creativity, critical thinking, collaborative learning and innovation, many educational institutions have chosen to use the pedagogical approach of problem-based learning (PBL). Moving from traditional teaching to PBL, however, demands an organisational change. Although organisational culture is widely recognised as a critical success factor in the implementation of PBL, the literature provides limited insight into how it influences the implementation process of PBL. This paper provides an empirical analysis of the influence of organisational culture on PBL implementation. The research is based on the analysis of two groups involved in implementing PBL for several years. A focus group interview was conducted with each group to identify traits of organisational culture. The Organizational Culture Assessment Instrument (OCAI) was applied to identify the dominant type of culture in each group. The findings indicate that some cultural traits better support the implementation of PBL. In particular, traits of clan culture were identified to be more aligned with PBL principles. In addition, understanding the current culture of a given organisation enables people to be more aware of the level of change required to implement PBL in their organisations.

KEYWORDS: PBL implementation, organisational change, organisational culture, problem-based learning, project-based learning, type of cultures

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INTRODUCTION

In the past 15 years, many universities across the world have started the process of changing from traditional teaching (lecture based) to problem-based learning (PBL) in its different conceptions. Central ideas of this approach are that learning is constructive, collaborative, self-directed and the result of a critical-thinking process. It thus is argued that PBL promotes ownership, engagement, interdependence and the ability to make decisions (Barge, 2010; de Graaff & Kolmos, 2003; Savery, 2006).

Several theoretical and empirical contributions have concluded that organisational phenomena play a significant role in the successful implementation of PBL. These include leadership, participation and organisational culture (Kolmos, 2010; Kolmos & de Graaff, 2007; Li, Du, & Stojcevski, 2009). Yet, organisational phenomena often are mentioned only in passing as an auxiliary factor or a practical implication of implementing PBL.

A common aspect of PBL implementation models is the interaction between the pedagogy and change-management layers, which thus connect micro-level activities (at the classroom level) with macro-level structures (leadership and organisational culture). Empirical research, however, fails to include the tools, techniques and methods used to explore organisational culture and its influence on PBL implementation. Thus far, the longstanding and rich theoretical tradition of organisational culture has not been extended to work on PBL implementation with some exceptions (Kolmos & De Graaff, 2007; Li, 2013; Li et al., 2009).

When an institution of higher education aims to implement PBL, it should also consider which aspects of the organisation need to be changed. According to Li, Du and Stojcevski (2009), organisational models analysing the structure, the struggle for power, the cultural aspects of the organisation and the driving forces for change are helpful to understand an educational institution in the process of changing to PBL.

Kolmos and De Graff (2007) developed a model that considered the importance of the organisation, culture and values in this change process. Their model has a curriculum layer and an organisational and values layer. The curriculum layer includes goals, assessments, teachers, teaching and learning methods, students and content; the organisational layer comprises culture, values, physical space and resources. For Li et al. (2009), this model is useful to guide curriculum reform and to explain why some curricular change initiatives fail when only one element of the system is changed. They state, however, that this model lacks a clear definition of the ‘organisation layer’.

Moesby (2004) proposes a model of change to PBL related to the vertical aspect of change in the organisation. The author argues that change occurs at different levels: individual, group/system and institutional levels. The individual level refers to an isolated, personal initiative of implementing PBL, often without any conceptual or cultural awareness of PBL. The group level is the transition process in which the organisation starts to systematically organise activities related to PBL. The highest level is the institutional level, which leads to the change of the entire organisation. Li et al. (2009) argues that this model helps identify at which level an organisation made a change; they specify, however, the need to have a more systematic method of analysing the change in an organisation when implementing PBL.

Inspired by these two models, Li et al. (2009) propose an organisational model focusing on the organisational level involving four aspects: curriculum, organisational structure and regulation, infrastructure and resources, and organisational culture. Their model has the following three characteristics. The first is cultural change focused on the organisation; without a change in the organisational culture, change to PBL is superficial and cannot be sustained because the values, attitudes and behaviours of members of the organisation do not change. Second, all aspects of the organisation are involved when conducting organisational change. Lastly, the model helps explain the deadlock and failure of organisational change in some educational institutions.

To our knowledge, Li et al. (2009) developed the best conceptual framework for change to PBL, combining elements of change from the curriculum and organisational levels. The central element of the model is organisational culture, but their work lacks a thoughtful discussion regarding this notion. They present a definition of organisational culture and an argument about the need to change the culture and create a supportive atmosphere to have a lasting change, but they do not discuss deeper organisational culture implications nor does the case presented in their paper cover the influence of organisational culture in PBL implementation.

The aim of this research is an in-depth examination of organisational culture to understand on a deeper level the implications it has on the process of implementing PBL and to get some insights for the model developed by Li et al. We accomplished this by studying the organisational culture of two groups of a public university in Costa Rica that have attempted to implement a PBL approach in the past 7 years.

These two groups are examples of complex relations and interactions that comprise parts of the university's organisational culture. In the organisational culture literature, such groups often are referred to as subcultures (Umbach, 2007). The actions and expressed values and meanings of the groups are seen as specific cultural materialisations of general phenomena which come into play when trying to implement PBL. In this way, the cultural

traits of the two groups are rich examples of the different cultural forces at play in the university where the research was conducted. As such, they provide useful examples that illustrate how culture affects the change towards PBL.

This paper addresses the following research question: How does organisational culture influence the process of change towards PBL? The next section presents the theoretical framework. The following sections introduce the methodology, the data presentation and analysis, and the answer to the research question; the final section draws conclusions.

PROBLEM-BASED AND PROJECT-BASED LEARNING (PBL)

The problem-based approach was originated in health professional education at McMaster University in Canada in the 1960s. In the 1970s, the approach was established by Maastricht University in Netherlands. At almost the same time, in Denmark, Aalborg University and Roskilde University were created with PBL as the institutional pedagogical approach, with the variation that their approach was focused on project- and problem-oriented learning (Kolmos, 2015). Since its original creation, the PBL approach has expanded to many countries, disciplines and universities, creating many variations of it.

In this work we understand PBL as described by Du, de Graaff and Kolmos (2009, p. 1): 'the new notion of PBL represents a learning philosophy rather than the details in the organization of the curriculum and goes far beyond a narrow curriculum change. This learning philosophy encompasses both problem-based and project-based learning. Furthermore, PBL includes a cultural change and foster new epistemologies in the creation of knowledge and innovation'.

We argue that the many variations of PBL can be located between two well-known experiences: Maastricht University (MU) and Aalborg University (AAU). Moust Van Berkel and Schmidt (2005, p. 667) define the Maastricht approach as 'a strategy that students use to explain underlying mechanisms, processes or principles of phenomena described in a problem. This strategy comprises well-known problem-solving procedures as well as scientific approaches used in research'. Dirckinck-Holmfeld et al. (2009, p. 157) define the POPP/PBL (Aalborg University approach) 'as a dynamic pedagogy where participants bring new problem areas to be studied. The problems to work with are not pre- defined by the curriculum or faculty but brought in by the students and further elaborated in discussions and negotiations between peers, faculty and external stakeholders'.

One way to identify the PBL modalities is to use the work by Ryberg, Koottatep, Pengchai and Dirckinck-Holmfeld (2006), who argued that the level of control of the teachers and students over the problem (who controls the framing of the problem?), the process (how to define the way of work?), and the solution (to what degree is the solution open-ended or fixed?), define the variations of PBL.

Although several variations of PBL exist, all variations share core principles that we could call the DNA of PBL: It is student-centred, collaborative (team-based), organised around real and contextual problems, and interdisciplinary (Kolmos, de Graaff, & Du, 2009; Savery, 2006). In addition, they share the role of the teacher, the fact that students own the learning process, and that students must apply critical thinking to deal with the problem and to their own learning process (Kolmos et al., 2009; Savery, 2006).

Organisational culture

The transformation towards PBL can be classified as a major organisational change that demands a change in organisational culture (Li et al., 2009; Li, 2013). How organisational culture is conceptualised has been debated for many years since its emergence in organisational discourse in the 1980s. Today, organisational culture is an established tradition of its own, and many scholars and practitioners frequently use the term *culture* when they refer to how organisations are managed – but still without really having reached any consensus concerning what it is.

Within the academic community, Smircich (1983) provided an early but still important overview of different approaches to organisational analysis. She stated that culture has been borrowed from anthropology where there is no consensus about what it is. Her approach was not to reach a consensus but to differentiate between several conceptions of culture and show how these conceptions influence how people approach and work with culture. She made an important distinction between culture understood as a *variable* – as something organisations *have* – or as a *root metaphor* – as something organisations *are*. The first treats culture as a typical soft factor in organisations in line with technologies, systems, strategies, structures and so forth. Culture is seen as a homogenous integrated system of shared values and assumptions. The second treats technologies, language, stories, systems, strategies and structures as complex and ongoing materialisations and expressions of culture.

Another two perspectives for understanding culture are the functionalist view (aligned with the variable perception of culture) and the symbolic view (aligned with the root metaphor perception). The functionalist view represented by Schein, who treats culture as if it was a variable (see the discussion by Schultz [2000]) and implies a coherent integrative view of culture in which culture becomes the shared glue between people.

This model of culture, which contains three levels (artefacts, values and basic assumptions), is an example in which deep, shared, basic assumptions ensure internal integration and external integration (Schein, 2010).

The symbolic view, which relies on a system or network of shared symbols and meanings (Alvesson, 2013), does not make such hard assumptions. Instead culture is more fragmented, ambiguous, inconsistent and full of paradoxes (Martin, 1992). According to this view, curriculum – including goals, assessment systems, teaching and learning methods, technologies, principles, contents, classroom designs and so forth – is a symbolic expression of culture, which is reinterpreted again and again, used and reworked within the educational institution, which in itself is an expression of culture. Everything becomes an expression of culture. The symbolic view of culture has spilled over to an understanding of corporate identity (Hatch & Schultz, 1997) as well as to theories of sense making (Weick, 1995) and sense giving as crucial processes by which organisations can manage changes (Gioia & Chittipeddi, 1991).

More recently, culture also has been understood through discourse, meaning that culture does not have a clear centre but is a network of relations in which are embedded norms and traditions for what can be said and done. Language has gained an important position because it is seen as a primary medium for both expressing and constructing meaning (Cunliffe & Eriksen, 2011; Hersted, 2016). This view also relies on crucial shared presumptions of culture: that culture is related to history and tradition, that it is collective and relational and as such exists in between people, and that it is both transmitted and constructed through shared symbols such as language (Alvesson, 2013).

Our position in relation to organisational culture is that culture is understood broadly as the ways things are done – including the doings of language – in organisations and the meanings attached to these doings. The focus is on how people together practice, create and shape the world in action and how they make meaning concerning these actions. Culture is thus embedded in words, expressions, concepts, guidelines, structures, appraisal systems, performance management, economic systems, strategies, policies, human resource management systems, etc. It involves continuous interpretation and reinterpretation as well as a degree of shared understanding and hence shared history because otherwise people in organisations cannot communicate and understand each other. In this sense, our understanding of organisational culture is aligned with the vision of culture as a metaphor, with the symbolic vision and with culture as a network of relationships.

Types of organisational cultures

As mentioned previously, manifestations of culture can be detected in values, norms and practices that shape the unique identity of each organisation. Researchers have created some taxonomies with common characteristics that associate a particular organisation to a particular type of culture. These types of cultures have implications for organisational change (Cameron & Freeman, 1991). In their work, Cameron and Freeman (1991) combined two frameworks to organise the different patterns of shared values, assumptions and interpretations that typify organisations. They studied four attributes (dominant values, dominant style of leadership, based for bonding, and strategic emphasis) among organisations. Four forms of organisational culture emerged: clan, adhocracy, hierarchy and market, creating the 'model of culture types for organizations' (Figure 1).

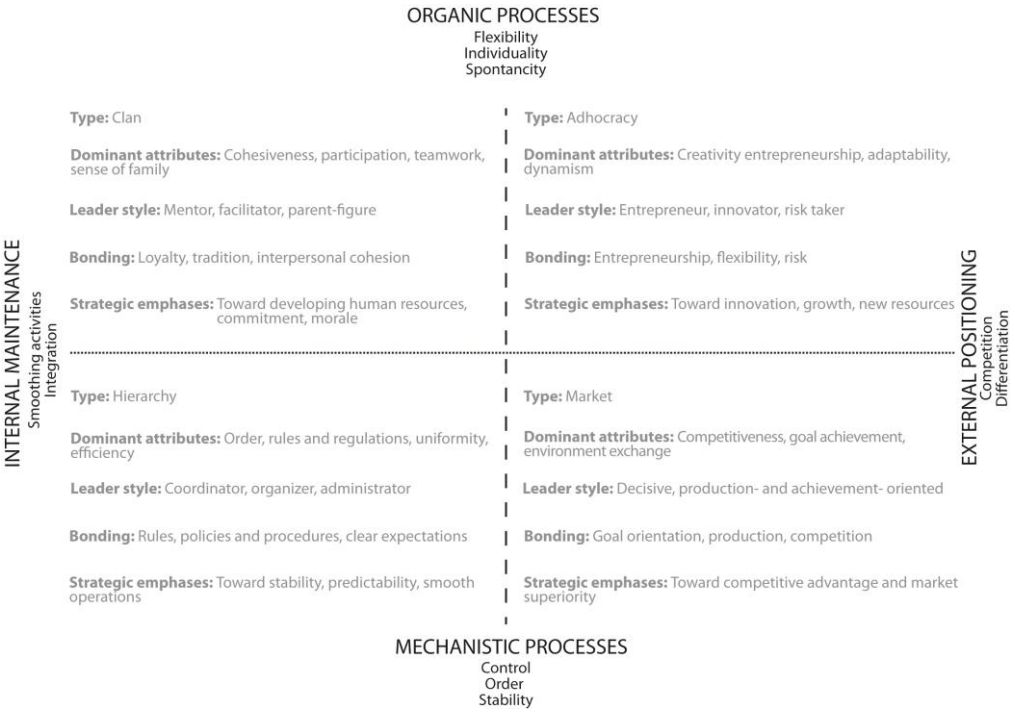

Figure 1. Types of cultures based on the work of (Cameron & Freeman, 1991).

Clan culture emphasises flexibility, and it is internally focused. Its characteristics are teamwork, employee participation and corporate commitment with employees. The adhocracy culture also emphasises flexibility and change, but it is oriented externally. Its key values are creativity, entrepreneurship and risk taking. A market culture seeks control and stability and is externally oriented. Its core values are goal achievement, consistency and competitiveness.

A culture of hierarchy also is oriented towards control but focuses on the internal organisation. Its key values are efficiency and close adherence to norms, rules and

regulations. An organisation rarely has a single type of culture; there is a mix of the four organisational cultures, but one of them is dominant.

ORGANISATIONAL CHANGE

As mentioned in the Introduction, there are some models dealing with the implementation of PBL as well as literature connecting PBL implementation with organisational change. According to some authors (Kolmos, 2010; Kolmos & De Graaff, 2007), each process of change to problem-based learning (PBL) is unique, and culture and contextual issues play an important role in the process and its results. Li (2013) explored the challenges and obstacles during the change to PBL in two universities and stated that, without a radical conceptual change in learning and knowledge for organisational members at the universities, the successful change to PBL was unlikely. Such change referred to the core values, beliefs and assumptions of the universities, which were the pillars of organisational culture.

Furthermore, organisational change literature shows culture to be a key element influencing the change process in organisations. It helps to identify readiness for change (Jones, Jimmieson, & Griffiths, 2005); it is necessary to cope successfully with change (Schein, 2010); it can hinder the implementation of initiatives with great potential (Patterson, 2000); and its deep understanding can facilitate the identification of appropriate change strategies.

Raj and Srivastava (2013) identified the effect of different types of culture on organisational learning and innovativeness. They demonstrated that adhocracy, market and clan cultures had a positive effect on organisational learning and innovativeness while the hierarchy culture had no positive effect. The adhocracy culture cultivated flexibility and creativity because its main goal was to adapt quickly to new opportunities. The market culture promoted organisational learning through the flow of information between internal and external constituents. The teamwork and employee development aspects of the clan culture fostered the proper utilisation of knowledge and improved learning and innovative capability. The hierarchy culture did not have an impact on organisational learning and innovativeness due to its characteristics, 'the employees do not have autonomy to perform the job... The formalised and centralised structure does not allow employees to approach the things from different and new perspective, therefore, does not provide opportunity to learn new things' (Raj & Srivastava, 2013, p. 215).

Suppiah and Sandhu (2011) also showed the influence of culture types on tacit knowledge-sharing behaviour. Clan culture was found to have a positive influence, while

both market and hierarchy culture types contributed negatively. In the same line, Biloslavo and Prevodnik (2010) found that clan culture, with its values of care for others and teamwork, was the most important type of culture for knowledge creation processes. Keskin, Akgün, Günsel and İmamoğlu (2005) also demonstrated that both adhocracy and clan cultures were considered crucial elements of tacit-oriented, knowledge management strategies, and that those type of cultures led firms to the effective implementation of tacit-oriented, knowledge management strategies.

De Long and Fahey (2000) argued that the importance of knowledge will change depending of the subcultures in the organisations because established group values and norms about what is relevant knowledge influences where the group focuses. They also stated that low trust cultures will constrict knowledge flow and organisations must rebuild trust levels in their culture before people start sharing expertise freely.

Summing up, from the literature, we dare to say that there is a need to study the organisational culture when an organisation is in the process of adopting PBL. As there is a change process taking place when trying to implement PBL, organisational change literature is needed to understand the process and to manage the change. Furthermore, a deep understanding of the specific organisational culture (where the change to PBL is taking place) will shed light on the level of change that must take place, and the core values that need to be strengthened or transformed. As knowledge creation, knowledge sharing and learning are necessary to support change, to know how these practices are done in the organisation is a key aspect to define the more appropriated PBL implementation plan in a given institution.

THE RESEARCH CONTEXT

The Universidad Nacional (UNA) since 2008 has had a pedagogical model that understands teaching and learning as a social, historical and cultural process that goes beyond the simple transmission of knowledge (Universidad Nacional, 2007). The model is based on constructivist principles in which the student is seen as the centre of the learning process. Further, it proposes an active and meaningful learning environment. As a model, however, it does not identify any specific teaching strategy, which means it is implemented in classrooms in a diversity of ways.

In the particular case of the School of Informatics (ISchool), the application of the pedagogical model depends on the nature of the courses and on the pedagogical knowledge of the faculty who teach the course. With the aim of providing students with a set of skills such as problem solving, effective communication, effective group work, professional responsibility and the capacity of lifelong learning, there have been in the

past 10 years two educational initiatives which seek to move the traditional pedagogical approach towards a PBL pedagogical approach. These two groups were working within the AAU model but with different levels of control by teachers and students.

Group 1: The IP group

The initiative to introduce PBL into programming courses was part of an institutional, exploratory research project in 2011–2014 aimed at integrating the principles of PBL from the early stages of the curriculum. In this group, the change towards PBL was seen as a gradual process mainly based on positive learning experiences for faculty and students. The pedagogical change was designed integrating the following principles of PBL (Mora, Coto, & Alfaro, 2014):

- Problems as a stimulus for learning: The starting point for learning was a problem related to situations familiar to the students. In general, teachers defined the problems.
- Collaboration: Students worked in groups to address learning activities. Each student was responsible for his or her individual performance, and positive interdependence was stimulated and complemented by a participatory evaluation.
- Autonomy: The students had to make decisions about some learning activities and assume a greater responsibility in the evaluation process.
- Participatory evaluation: Students used self-assessment and peer-evaluation strategies to reflect critically on their learning process and contribution to joint objectives.

From an internal organisation point of view, the group has a coordinator who establishes agreements regarding the subject content, learning activities and assessments. The role of the coordinator has been predominant, providing colleagues with clear guidelines about how to deliver the course and the teaching material to use in classrooms. The group is comprised of 10–12 faculty members, diverse in experience and age. Most are full-time staff, but about half do not have a permanent position at the ISchool. At the end of each semester, faculty members meet to share experiences and outcomes (Lykke, Coto, Mora, Vandel, & Jantzen, 2014).

The IP group faced some obstacles related to organisational issues, including the instability of faculty staff. The academic staff change from one semester to another, making it difficult to consolidate a group and achieve the objectives. Another obstacle was the lack of positive communication between faculty and difficulties in consolidating an effective group work. Finally, there was a lack of clear direction from the school

authorities regarding the change process towards PBL and the commitment of faculty staff to it (Mora et al., 2014).

Group 2: The SE group

In this case, the change towards PBL started as an initiative of the SE group with the goal of enhancing students' skills regarding the development of projects related to the industry. The SE group implemented the pedagogical approach through a sequence of three courses (1 1/2 years) in which the students must develop a software project in a real company. As such, they have the opportunity to choose the company and have more control over the problem to be addressed. These differences with the IP group are related to the nature of the courses and the maturity of the students because the IP students are in the first year of the program while the SE students are in their third year.

To implement PBL, the number of lectures in the courses have decreased and the supervision and workshop sessions have increased. The supervision sessions are about 30% of the first course, 40% in the second course, and 60% in the third course. These sessions emphasise best practices in project management and students' autonomy. Students work collaboratively during the three semesters and are responsible for formulating their own ethics code, resolving their conflicts, and presenting possible solutions to the problems that can arise. They also use strategies of self-assessment and peer assessment to promote responsibility and reflection (Sandoval, Cortés, & Lizano, 2015).

From an internal organisation point of view, the group has a coordinator who is the person with the most working experience at the ISchool. The group is comprised of 8–10 faculty members. They are balanced regarding experience and age: all have professional experience in the industry and most are part-time staff who do not have a permanent position at the school. An annual workshop is carried out to analyse learning activities, learning outcomes and their alignment with the PBL approach (Sandoval et al., 2015).

Regarding organisational matters, this group reported some challenges. To some extent, they had to work against the established institutional teaching norms to change the teaching structure. They also requested more clarity from school authorities regarding what the change to PBL means and the workload required. Finally, they felt vulnerable as a group because their conformation depended on the support of the authorities in turn.

METHODOLOGY

Two methods were used to collect data: a focus group and the Organisational Culture Assessment Instrument (OCAI). Both methods were applied to both the IP and SE groups. Table 1 shows the participants from each group. Eleven members of the IP group and 10 members of the SE group were invited; participation was voluntary. The only selection criterion was that they were part of the group at some point during the past 5 years.

	Focus group	**OCAI instrument**
IP group	3	8
SE group	5	5

Table 1: Research participants

The focus group

To learn about the organisational culture of each group, in relation with our understanding of this concept, we needed a qualitative method to provide inputs about group dynamics, values, traditions, process, work organisation, group assumptions and the level of adoption of PBL in their teaching practice. We chose to use a focus group, but integrated the Lego Serious Play (LSP) methodology (Kristiansen & Rasmussen, 2014) to facilitate the expression of emotions; promote cognitive, metaphorical and reasoning thinking; and foster storytelling. The LSP methodology ensures that all participants have time to participate. Following the principles of LSP, each participant had the opportunity to build, share and reflect about the different questions.

A focus group was carried out with each group. The main questions that guided the activity were:

- What is the regular structure of your classes?
- What are the group dynamics?
- How is the collaborative work between the group members?
- How is collaboration between ISchool faculty?
- What is the level of adoption of PBL in the teaching practice of the group?
- What have been the challenges to adopt PBL in the group?
- What would be the challenges to adopt PBL at the ISchool level?

Three people participated from the IP group and five from the SE group. The coordinators of both groups participated in the focus group. The focus groups lasted about 2 hours and were video recorded. We used Goldring's six traits of culture (2002) to analysis the focus group data and identify important shared patterns of meaning associated with vision, collaboration, tradition, decision-making, communication and innovation (see Table 2).

Trait	Description
Shared vision	Reflects the shared meaning developed through the history of the group. It is based on values and speaks about what is considered important and what kind of environment and relationships are promoted. It also includes leadership.
Traditions	Action, metaphors, symbols and ceremonies that make visible the values and assumptions.
Collaboration	When members work together to accomplish tasks. It considers the stated and tacit expectations about group behaviour and work.
Shared Decision-Making	The way in which a group makes decisions shows the values of the group. Formal and informal decisions translate values into actions.
Innovation	Includes dealing with changes that challenge existing assumptions and beliefs of the culture. This trait also refers to how groups dealt with changes and innovations.
Communication	The way the group expresses itself, including the emotions of its members. Communication supports the process of information exchange, problem solving, decision making, creating relationships and building practises, and it helps groups and individuals achieve their goals.
	Based on Goldring (2002).

Table 2: Description of the six organisational culture manifestations

We analysed information from the focus group in two steps. First, two of the authors individually listened to and watched the video for each focus group, taking notes about data that informed the six traits of cultural manifestation and general aspects or comments that captured their attention. Second, they compared their notes and developed a description of each of the six traits as well as a consensus interpretation of the overall characteristics of each group and their level of PBL adoption.

The OCAI instrument

A second instrument were used to gather insight about each group's type of culture (if there was any difference). This was considered important because there exists literature relating the type of cultures with organisational change, organisational learning and knowledge sharing.

We used an organisational culture measure based on the Organizational Culture Assessment Instrument (OCAI; Cameron & Quinn, 2006). The OCAI helps uncover aspects of the organisation's culture that might otherwise not be identifiable or articulated by its members. It assesses six key dimensions of organisational culture: Dominant Characteristics, Organizational Leadership, Management of Employees, Organisational Glue, Strategic Emphasis and Criteria of Success. In each dimension are four descriptions that match with each of the four culture types in the model: adhocracy, clan, market, and hierarchy. For this study, the Management of Employees dimension was changed to Coordination Style, as it better reflected the nature of the 'management' in the analysed

cases. We used a version of the OCAI in Spanish; the standard OCAI instrument is available at http://my.ilstu.edu/~llipper/com435/survey_ocai_culture.pdf.

To complete the OCAI, individuals divide 100 points among four alternatives, depending on the extent to which each alternative is similar to the organisation (unit, department, group, etc.) under study. The idea is to give a higher number of points to the alternative that is most similar to the organisation (in this case, each group under study); thus, the participants provide a picture of how their organisation operates and the values that characterise it. The scoring of the OCAI was accomplished by averaging the response scores for each alternative. By averaging the individual OCAI scores, a combined profile of the organisation can be developed.

Table 3 presents the distribution of the survey. OCAI responses were anonymous so it is uncertain if the people who completed the questionnaire also participated in the focus groups.

Groups	Distribution	Rate of return
IP	11	8
SE	10	5
Total	21	13

Table 3: Survey distribution and responses

RESULTS

This section presents the results derived from the focus group and the OCAI instrument, relating the findings of both instruments.

Focus group

We can identify some organisational culture manifestations in each group, as well as the level of adoption of PBL. Regarding the adoption of PBL, the SE group has managed to adopt PBL into the teaching practice while the IP group is still struggling. Regarding the way they interact with and create meaning for the different daily activities, we can note that the SE group has a strong teamwork characteristic, supported by a participative leadership approach, healthy communication, an interest for continuous learning and a clear shared vision. Furthermore, the group highly values the friendship among its members. On the other hand, the IP group could be characterised as a function-oriented, highly professional group, with a strong and professional leadership, an orientation to work cooperatively rather than collaboratively, with a shared blurred vision and with mainly unidirectional communication. The details are shown in Table 4.

Categories	SE group	IP group
Shared vision	The main motivation seems to be to develop the knowledge and skills that students should acquire for their future professional life. Several participants mentioned their happiness and satisfaction regarding seeing the professional growth of the students. They have a clear shared vision about how to achieve this goal and how they as a group can contribute. The use of *we* and *our* clearly expressed the sense of *we-ness* mentioned by Cameron and Quinn (2006). This frequent use of *we* provoked the feeling of a single voice and identity of the group. Another element that supported this shared mission was participants' history together and stories. They worked together for many years, and there were many anecdotes and stories to share. The type of leadership present was shown to be a key success factor. The members agreed that the leader was an open person who was willing to listen, make changes, value the human resources and motivate them to work.	The shared vision in this group was not as clear as in the other group. They had a vision, but it was a vision or a task given by the ISchool curriculum. As individuals, each was committed to student development and improving their teaching practise. However, the vision of the future they wanted to construct was not easy to interpret. The leadership of this group was more task oriented and less focused on a participative approach. When asked about how the group worked, the leader said 'dictatorial', meaning that she decided how things should be done. The other members replied, however, that it was a very organised and well-coordinated group.
Traditions	The group mentioned that they used to meet at the members' houses outside working hours and for birthday parties. They like this practise, as they got to know their colleagues' families. Some traditions were manifested as tales about the organisation and their members, thus creating a story. This trajectory as a group was present in the members and created pride.	There was no evidence of large traditions in the group. It seems that the frequent changes of members did not allow for the creation of a history or a common memory of the group.
Collaboration	From the description of their way of working, it seems as though the SE group worked collaboratively. While there was a division of tasks, the SE group put great effort into the creation of knowledge to improve their practise, and members kept in constant communication during the semester. There was a healthy environment for giving and receiving feedback.	Although the group seemed to work collaboratively in a collegial and friendly atmosphere, it was evident that their members were not ready to receive feedback from others regarding their knowledge or expertise. One participant shared a situation she faced weeks before the focus group took place. She recommended making some changes to an exam that two other colleagues designed. She made the recommendations with good intentions, but the feedback was not well received, provoking an internal group conflict.
Shared decision-making	The group was characterised as a more decentralised group in which the coordinator did not dictate how things should be done but promoted shared decision making. Decisions were more experience based and oriented toward knowledge sharing.	The group showed higher levels of control and concentration when making decisions than the SE group. The coordinator made many decisions to apply the PBL approach and designed many teaching activities.
Innovation	The group assumes changes and uncertainties as a learning opportunity. An integral part of its dynamics as a group is constant innovation. They were unafraid to introduce new approaches and initiatives,	Innovation is an important value for the group; each semester they look for new approaches for improving teaching practise. The initiatives often come from group leaders, however, and are presented

	even when these went against some institutional rules.	as guidelines for other members to follow. They are very careful to frame these initiatives in institutional policies and rules.
Communication	Communication was informal and friend oriented. They communicated a great deal through email and had a WhatsApp group where they exchanged information, asked questions and made decisions. They also had face-to-face communication channels, such as coordination, planning and self-reflection meetings. One of the highlighted aspects in this group was their language. During the focus group, they often used words/phrases such as learning, humility, passion, love, teamwork and lessons learned. It seemed that they also were open to expressing their opinions and points of view, as well as their eventual lack of knowledge about some topics.	The group used email as the everyday communication channel and face-to-face meetings to coordinate, plan and evaluate, but this communication was more vertical than in the SE group. In other words, most of the emails contained messages from the coordinator to the members about issues that needed to be done to keep up with the scheduled learning activities. The discussion and exchange of opinions and points of view took place normally at the beginning and the end of the semester. The incident with the faculty member who provided feedback about the exam was an example of the way they communicated as it was not discussed or solved openly within the group.
PBL level of adoption	The participants affirmed that the PBL approach was very well established in the courses. Faculty members in the group were highly motivated and understood their role as facilitators. They defined themselves as a fragile group, however, as PBL was not an approach directly promoted by the ISchool; rather, it was their group's way of working. As challenges for a successful implementation of PBL, members pointed out aspects such as increased support from the authorities and a more balanced workload.	The group defined its level of adoption as 'individually adopted' because only certain faculty members who had experience with the approach were using it, and there were no new initiatives or policies to use the approach in the programming courses. The group pointed out aspects such as increased support from the authorities and a more balanced workload as keys to successful implementation of PBL. They also indicated the need to overcome some faculty members' resistance to change, a better collaborative environment and a general change of mentality at the ISchool.

Table 4: Focus group results

OCAI instrument

Scoring the OCAI requires simple arithmetic calculations. The first step is to compute an average score for each of the four alternatives (each related to one type of culture: adhocracy, clan, market and hierarchy), and then a mean score for each quadrant is calculated from the six dimensions. The higher the score, the more dominant the cultural type is (Cameron & Quinn, 2006). For example, Table 5 shows the data of the five participants of the SE group with respect to the Dominant Characteristics dimension. This dimension, like the other five, is composed of 4 items, where A corresponds to a value related to the Clan culture type, B to the Adhocracy culture, C to the Market culture and D to the Hierarchy culture. The results for this dimension show a high tendency to B (the Adhocracy culture).

Dominant Characteristics	P1	P2	P3	P4	P5	Average
A. The group is a very special place. It is like an extended family. People seem to share a lot of themselves.	25	10	10	10	30	17.0
B. The organization is a very dynamic and entrepreneurial place. People are willing to stick their necks out and take risks.	25	10	50	60	20	33.0
C. The group is very production oriented. A major concern is with getting the job done. People are very competitive and achievement oriented.	25	40	20	20	30	27.0
D. The group is a very formalized and structured place. Bureaucratic procedures generally govern what people do.	25	40	20	10	20	23.0

Table 5: OCAI data for the SE group, Dominant Characteristics dimension

Table 6 shows the results of these calculations for each of the six dimensions, presenting the average values for the SE group. In this group, the dominant culture type was a clan culture (39.33 points), which means that basic assumptions and values of the clan culture predominate in the SE group and that most members saw the group as a friendly place where they shared a great deal about themselves. This was supported by the data from the focus groups where they referred to their shared histories and traditions, and the time that they spent together getting to know each other and their families. In this sense, the SE group was held together by a mix of components, such as shared vision, loyalty and traditions.

A clan culture places a strong emphasis on the long-term benefit of human resource development and attaches great importance to cohesion and morale. These traits could be perceived in the SE group's work methods, the willingness of the members to learn together and the emphasis placed on consensus and shared decisions.

Dimension	Type of culture			
	Clan	Adhocracy	Market	Hierarchy
Dominant Characteristics	17.00	33.00	27.00	23.00
Organizational Leadership	22.00	20.00	26.00	32.00
Coordination Style	56.00	22.00	10.00	12.00
Organisational Glue	44.00	24.00	22.00	10.00
Strategic Emphasis	48.00	28.00	9.00	15.00
Criteria of Success	49.00	21.00	8.00	22.00
Average	39.33	24.67	17.00	19.00

Table 6: OCAI results of the SE group

From Table 6 we also can see that there is a well-marked difference between the culture that obtained more points (clan) and the culture next highest in points (adhocracy). The higher the difference between the different types of cultures, the stronger the culture. A strong culture corresponds with a clear sense of direction, homogeneity of efforts, an unambiguous environment and services.

Next we calculated the results for the IP group. As shown in Table 7, this group was operating as a hierarchy culture, with 31.56 points, but almost equally as a clan culture, with 28.23 points.

Dimension	**Type of culture**			
	Clan	**Adhocracy**	**Market**	**Hierarchy**
Dominant Characteristics	26.88	28.75	18.13	26.25
Organizational Leadership	17.50	17.50	28.13	36.88
Coordination Style	35.00	14.38	25.00	25.63
Organisational Glue	30.63	15.63	13.75	40.00
Strategic Emphasis	27.50	33.75	11.88	26.88
Criteria of Success	31.88	25.63	8.75	33.75
Average	28.23	22.60	17.60	31.56

Table 7: OCAI results of the IP group

The IP group has a mixture of cultures in which the emphasis is on procedures and planning. The high values for hierarchy show that IP group members largely perceive the way they work and interact within the group as being determined by a set of rules and procedures that told them what and how to do their work, with a strong emphasis on values like control, efficiency, consistency and uniformity. Evidence of this situation was found in the focus group in which participants affirmed that the group worked in an orderly and organised way, and that they had clear guidelines (given by the coordinator or leader) for how to deliver the course. It was very important for the IP faculty members and coordinator to look for uniformity in the different classroom groups.

In a hierarchy culture, it is also possible that within the group, many of the members are not used to being responsible and to playing a critical role in the decision-making process. The focus group also revealed traits like this in which it was evident that all decisions are finally made by the coordinator.

The proximity to the clan culture can be understood in the collegial and friendly atmosphere among the members and the interest in teamwork and empowering faculty staff to learn and implement PBL in their classrooms.

Comparison of the SE and IP groups' results

We further examined organisational culture by analysing the six dimensions of the OCAI instrument. Table 8 presents the dominant type of culture for each group in each dimension.

	SE		**IP**	
	Dominant culture	**Average value**	**Dominant culture**	**Average value**
Dominant Characteristics	Adhocracy	33	Adhocracy	28.75
Organisational Leadership	Hierarchy	32	Hierarchy	36.88
Coordination Style	Clan	56	Clan	35.00
Organisational Glue	Clan	44	Hierarchy	40.00
Strategic Emphasis	Clan	48	Adhocracy	33.75
Criteria of Success	Clan	49	Hierarchy	33.75

Table 8: OCAI results by dimensions

Congruence on the six aspects means that all the dimensions are based on the same values and fall into the same cultural quadrant. According to Cameron and Quinn (2006), research has shown that successful organisations often have a congruent culture because having all aspects of an organisation focused on the same values and sharing the same assumptions reduces the obstacles to achieving goals effectively. From Table 8, we can see that the SE group can be categorised as a more congruent culture than the IP group, which shows no particular pattern of similarity.

Analysing the data in Table 8 in greater detail, we can see that there are no differences between groups in the three first dimensions. For the Dominant Characteristics dimension, both groups have the adhocracy culture, which means that both subcultures are dynamic and willing to take risks. The SE group was slightly higher in this aspect, however, which is congruent with the information obtained in the focus group where members described the how they responded when they felt threatened by some authorities, showing that they are good at fostering adaptability, flexibility and creativity in uncertain and ambiguous situations.

For the Organisational Leadership dimension, both groups showed a hierarchy culture, which means leadership is considered as a way to exemplify, coordinate and organise. In this dimension, the score for the IP group is higher than the score for the SE group. This again is consistent with the focus group results which showed that leadership in this group was perceived as a more 'dictatorial', and more task and results oriented than in the SE group.

In the Coordination Style dimension, both groups have clan culture, which means that group coordination is characterised by teamwork, consensus and participation. The difference between the two scores, however, is the highest of all dimensions. This result was clearly perceived in the focus groups in which members of the SE group stated that the leader or coordinator was an open person who was willing to listen, motivate them to work and promote shared decision making. On the other hand, data from the IP group showed higher levels of control and concentration of decisions in the coordinator. Therefore, even when both groups share the same type of culture, differences in their scores are clearly manifested in group behaviour.

The Organisational Glue dimensions indicated that for the SE group, the key aspect that keeps their members together is mutual trust, while for the IP group, it is formal rules and policies. This result is congruent with the information given in the focus groups regarding shared vision, collaborative approach to work and traditions.

The results from the Strategic Emphasis dimension reinforce that the SE group has a focus on members' development, trust, openness and participation, while the IP group shows a tendency to try new things and create new challenges. Regarding the Criteria of Success dimension, the OCAI data indicate that the SE group defines success based on human resources, teamwork and commitment, but for the IP group, the most important success indicator is efficiency. These results were supported by the focus group data and the process each group followed to implement PBL.

Given the theoretical and empirical research on PBL (Barge, 2010; de Graaff & Kolmos, 2003; Li et al., 2009; Savery, 2006), it can be argued that the PBL principles are collaboration, self-directed learning, trust, respect, team building, ownership, engagement, interdependence and critical thinking. When analysing the previous principles and the theory about types of organisational cultures (Cameron & Quinn, 2006), it may be concluded that the PBL principles are more aligned with the characteristics of clan and adhocracy cultures. Furthermore, between the two, clan culture is even closer to PBL principles, as in both there is a strong emphasis on collaboration, teambuilding and human development. This theoretical inference is supported by the empirical data; the culture manifestations of the SE group seem to be closer to the principles of PBL, and this group is also more aligned with a clan culture. Therefore, it can be concluded that, in our research context, PBL principles are more closely connected to the clan type of culture.

How does Organisational Culture Influence the Process of Changes towards PBL?

The research question establishes a relationship between organisational culture and the successful implementation of a PBL pedagogy approach in a traditional higher education institution. We found two implications of organisational culture in the PBL implementation process. The first refers to the extent to which a particular culture is aligned with PBL principles (desired culture), which in turn defines the required level of change. The second aspect relates to the way in which a particular culture better supports organisational learning and therefore organisational change towards PBL.

Regarding the first aspect, as both groups aimed to use PBL as a pedagogical approach, the key principles of PBL were compared with each group's organisational culture. The data show that the SE group has culture manifestations that better match the PBL principles than the IP group. In this sense, the adoption of PBL by the SE group should be smoother and quicker. For the IP group to implement PBL, the level of change is more significant, as the group would need a greater reinterpretation and reconstruction in their beliefs, values and behaviours. The construction of new meanings, interactions, artefacts and shared language that are not part of their current organisational identity is necessary. It is important to understand, however, that the adoption of PBL does not mean that the current cultural manifestations are going to be totally abandoned but reinterpreted and modified to support the new way to understand teaching and learning (in other words, PBL). In this sense, a movement from the IP group towards a more PBL pedagogical practice means more empowerment of their members, more participation and involvement in decision-making, and more effective teamwork. It does not mean a lack of coordination or failure to follow ISchool policies and rules.

With regard to the second aspect, we refer to an organisational culture that supports learning and change processes. When PBL is implemented, it is a fact that the change will take place. The alignment between the current culture and the desired culture will determine the required level of change. Another important factor to consider, however, is if the type of organisational culture present in a particular group or organisation favours processes of learning and change.

We can state that both groups have a strong orientation to change and learning. The decision to implement PBL was a product of a reflection process about how to improve their university teaching practice. The SE group has been involved in a continuous process of promoting organisational growth by questioning all organisational practises, even their own teaching practises, and this promoted an awareness and willingness to change beliefs and values. On the other hand, the IP group has been struggling to adjust PBL to its current values, rules and practices.

From analysis of the data, we can conclude that the SE group has a culture that better promoted organisational learning, innovativeness, knowledge creation and sharing than the IP group. As the OCAI shows that the SE group has a clan culture, this conclusion is supported by empirical work presented previously (Biloslavo & Prevodnik, 2010; Raj & Srivastava, 2013; Suppiah & Sandhu, 2011). As Cameron and Quinn (2006) stated, strong cultures have the needed conditions to face a change process, such as clear focus and common vision, while congruent cultures contribute to facilitating change and reduce the obstacles to achieve goals effectively. The SE group has both a strong and a congruent culture. In other words, if the ISchool decides to implement PBL, the SE group is more prepared for it. There already are group values, such as trust, teamwork, organisational learning and a culture of knowledge sharing, which the literature associates with key factors for learning and change processes.

CONCLUSIONS

The aim of this paper was to provide a general view of the main interconnections between organisational culture and the process towards PBL. When we considered the organisational theory literature, we identified the connection among organisational culture, organisational change, learning and change readiness. Understanding the organisational culture will assist in the process of understanding why organisations respond in a certain manner to the implementation of PBL. The different understanding of organisational culture will influence how to approach a PBL implementation process.

Within a variable approach, the understanding of organisational culture may support the process of creating readiness for implementing PBL as well as facilitating the management change process that needs to take place. Within the metaphor approach, the understanding of organisational culture sheds light on rethinking who the group is as an organisation; redefining organisational identity; and reinterpreting and reconstructing their beliefs, values and behaviours. Aligned with the metaphor approach and within our understanding of organisation culture – which considers PBL to be a learning philosophy and not only a pedagogical approach – we mean the PBL implementation process needs a construction of new forms of interaction, and creation of knowledge, joint work and meaning making. In other words, the organisation must go through a process of reification of values, beliefs and assumptions into a new organisational practice.

This study adds to Li, Du and Stojcevski's (2009) model of organisational culture as the centre of the PBL implementation process. The research used concrete instruments and empirical data to understand the cultural traits that must be fostered to move towards PBL and how the different understandings of organisational culture influence the approach to this process.

The research is limited to two small groups within a university faculty, and it should be taken as an exploratory study regarding the findings. Therefore, future research should be directed towards collecting and analysing data regarding organisational culture across a greater number of departments or universities to develop more empirical evidence on the influence of organisational culture and the implementation of PBL. It also is important to develop research on the general dimensions of organisational culture that correspond to the values and beliefs underlying PBL.

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Random Allocation of Students into Small Groups in Problem-Based Learning can Create Significant Between-Group Variation During the Assessment Process

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ABSTRACT

In problem-based learning large cohorts of students are divided into smaller groups that pursue learning objectives with separate instructors called tutors. This presents challenges for tutors tasked with providing similar educational experiences and assessment of multiple groups of students. Here we evaluated between-group variation in test scores that are attributable solely to the random sampling without replacement process used to form smaller groups. We then compared this with the actual between-group variation in test scores in a university-level zoology class over 4 years. We found the variation attributable exclusively to group formation accounted for a 14.4-16.2 point differential between groups whereas differences in empirical test scores attributable to group formation and other factors such as tutor capacity and group dynamics ranged from 12-18 points and rarely exceeded the variation inherent solely to group formation. This implies ad-hoc strategies for reducing variation between groups at the assessment phase will have limited success.

Key words: Problem-based learning (PBL), between-group variation, assessment, grades

INTRODUCTION

A number of disciplines have incorporated active learning approaches, either partially or completely into their curriculums (Prince 2004; Galand & Frenay 2005). Problem-based learning (PBL) is one such active learning approach that has been present for a number of years in medicine (Barrows 1996) and engineering (Mills & Treagust 2003; Prince & Felder 2006) and has become more common in the fields of science (Akçay 2009; Mauffette & Poliquin 2001) and social sciences (Heycox & Bolzan 1991). Benefits of PBL approaches include

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promotion of soft skills (Bell 2010) as well as long-term retention of course material (Strobel & van Barneveld 2009). However, major concerns remain as to how students are assessed in PBL learning environments (Azer 2003, Macdonald & Savin-Baden 2004, Macdonald 2005). Baden (2004) expressed concerns that students in the PBL context may feel that their learning is unrewarded and that working in groups is undervalued. Since PBL relies on a constructivist framework and on collaborative learning, group dynamics play a critical role in the learning process (Savery & Duffy 2001) as well as during the assessment and evaluation phases of a course (Gijbels et al. 2005; Gijbels & Dochy 2005).

In the PBL learning environment, students from a large cohort are generally distributed in groups of 6 to 14 where course material is mastered through group-directed inquiry based around a problem or situation given to students by the tutor (Boud & Feletti 1997). We have implemented a biology program using a PBL format based on the practices of McMaster-Maastricht universities whereby our groups are typically 12 students that meet twice a week with a tutor (De Graaff & Kolmos 2003). We may have several tutors facilitating a given cohort all using the same problem. This presents challenges for educators tasked with providing similar educational experiences and assessment to these multiple groups of students. Students are tasked with identifying specific objectives, formulating and testing hypotheses using information such as primary literature and textbooks in an approach akin to the scientific method (Duch et al., 2001). During this process, tutors (instructors) are tasked with verifying that course objectives are covered during these discussions and intervene when necessary to clarify or redirect discussions. In our program, all students, regardless of group assignment, are evaluated with identical exams that are administered throughout the course. Under these circumstances significant variation in test scores often arises between groups suggesting that students are not receiving similar educational experiences among groups.

Potential sources for variation in test scores between groups may include differences in the quality/capacity of the tutor (Neville, 1999), differences in social dynamics between students within groups and even the initial selection and formation of groups prior to the course (Lowry et al. 2010; Lohman & Finkelstein, 2000). Selection and formation of groups differs fundamentally from other potential sources of between-group variation in that it occurs independently from the role of tutors or interaction among students within a group and its effects extend to all groups. Thus, variation in test scores due to group assignment may inescapably obscure the variation in tutors' capacity and student dynamics. As a consequence, differences in tutor quality/capacity determined by evaluations that are linked to student performance may be effectively masked unless differences among tutors are greater than variation created from group assignment. Likewise, the importance of within-group dynamics among students for test scores must exceed variation related to group assignment in order to be detectable. For these reasons, it is useful to quantify the variation in test scores between groups attributable strictly to group assignment as a baseline prior to the assessment of other sources of variation.

Relative to other factors, quantifying the effects of group assignment on the variability in test scores between groups is relatively straightforward. Each cohort of students enrolled in a course constitutes a random sample from larger population of students. If group assignment is based on random allocation of students to groups, the initial cohort of students is sampled without replacement. As with all sampling, allocation of students to groups and the variability of test scores between groups will depend on both the size and the number of groups. If the underlying distribution of test scores can be estimated for the larger student population, the allocation of students to groups can be analyzed via simulation to quantify the inherent variability related to the formation of groups.

Here we present simulations characterizing the variation in test scores between groups in a university-level course in a PBL program that is attributable exclusively to the initial selection and formation of groups. We compared the empirical variability between groups in a zoology course given between 2014-2017 based on tests given mid-term and at the end of the course to assess the relative variation attributable to other factors such as differences in quality/capacity of instructors or differences in group-dynamics. Assuming that maintaining similar educational experience between groups is desirable, we also suggest strategies for how a critical consideration of the allocation process of students into smaller groups could be changed to minimize between-group variation in a PBL context.

METHODS

We analyzed test scores from an introductory, university-level course in zoology in a PBL program in biology for our study. The course is required material for the baccalaureate program in biology at the Université du Québec à Montréal. The course counts for 7 credits of the total 90 credits within the program and takes place over 7.5 weeks during the second trimester. In this program, courses are offered sequentially rather than concurrently, thus students are involved only in this course during this period. During the second trimester, the course counts for more than half of the 13 credits offered. Enrolment in the course is ranges from ca. 75-85 students in a given year.

The course is divided into both practical and theoretical aspects. Practical aspects of the course are taught in a laboratory setting in larger groups where students concentrate on learning external and internal morphology and taxonomic identification. Theoretical aspects of the course are taught in smaller groups and led by a tutor (instructor) for the duration of the course. Each tutor is responsible for 1 (or less frequently 2) groups. Thus, in a given year there are typically 5-7 instructors assigned to different groups. Subject matter during this aspect of the course revolves around understanding phylogenies and major evolutionary transitions seen throughout the radiation of multicellular animals. Each class period, students are presented with

a short document that describes a problem/situation related to course subject matter. In these small groups with the aid of the tutor, students are expected to identify learning objectives and develop and use hypotheses to guide their inquiry. Once established, students verify these hypotheses using pertinent sources of information such as assigned reading from textbooks, current popular science writing in the media and peer-reviewed scientific literature. During this period, the tutor may intervene to clarify course material and assure that hypotheses and discussions revolve around material pertinent to the course. Students then meet to share and compare information responding to each hypothesis. The synthesis produced in these meetings serves as the base of course material that students use to prepare for exams. The tutor's role through this process is to guide students in the formulation of clear and verifiable hypotheses, to assure that pertinent subject matter is addressed with accurate information and to verify that students have met specific learning objectives for the course. For our analysis, we concentrated only on test scores from exams related to theoretical aspects of this course that were linked to performance in small groups with a single tutor.

Theoretical aspects of the course are evaluated twice during the course as a mid-term and final exam. Each exam has the same format and consists of 40% long-form essay response, 50% short response and 10% 'fill in the blank-type' responses and is based on a total 100 points. Long-form essay questions are broad questions that require students to integrate material from several problems/situations to support their responses that can be up to both sides of a single page. Short response questions require less development and target more specific aspects of the course. Fill-in the blank type responses consist of students correctly naming organisms associated with a phylogenetic tree that emphasizes evolutionary relationships among taxa. Exam scores (based on 100 points total) are then given letter grades as follows: A+>88%, A 85-87%, A- 82-85%, B+ 78-82%, B 75-78%, B- 72-75%, C+ 70-72%, C 68-70%, C- 65-68%, D+ 63-65%, D 60-63%, E<60%.

STATISTICAL ANALYSIS

For our analysis, we compiled mid-term and final exam scores between 2014 and 2017. We combined scores from all years to provide an overall empirical distribution of test scores for each exam. The empirical distribution was then used to choose reasonable parameters for beta distributions that were used in simulations. Beta distributions are convenient representations for student grades because 1) they are bounded between 0 and 1, which can be easily translated to 0 to 100% a standard scale for evaluations and 2) they can be negative skewed which captures well the large range of values associated with a failing grade (usually all notes <60). Beta distributions depend on two shape parameters (α and β). Beta distributions with parameter values of α between 4 and 5 and β between 2 and 2.5 have modes near 70% and a strong negative skew similar to the distributions of grades observed in university courses. For our analysis, we used four beta distributions where α=4 or 5 and β=2 or 2.5 to provide a realistic range of possible

student populations. We then simulated 1000 virtual cohorts where 80 values representing students were drawn at random from a beta distribution and then separated into 8 groups of 10. For each cohort, we calculated the maximum difference in mean test scores between groups. This value characterizes the largest difference in the mean test scores between groups in any simulated cohort. We summarized the differences generated through simulation to quantify the extent to which the selection/formation process influences between group variability in test scores. These simulations represent the between group variation in test scores that occurs exclusively as a product of random sampling without replacement and group assignment.

We also compared to the maximum difference in mean test scores between groups generated from randomizations of empirical data for mid-term and final exams. For these randomizations, student test scores were randomized and assigned without replacement into individual groups where each group had a minimum of 10 students. The number of midterm and final test-scores used in these simulations differed slightly within each year as some students dropped the course between the mid-term and final exam. Based on 1000 randomizations and group assignments, we estimated the distribution of the maximum difference in mean test scores between groups. These simulations represent the between-group variation in test scores that would occur following the selection and allocation of students to groups as well as other factors such as differences in quality/capacity of instructors or differences in group dynamics.

We then compared between group differences in test scores between both sets of simulations to determine the extent to which factors other than the selection process and group formation contribute to differences in test scores between groups. We hypothesized that on average the differences in test scores between groups derived from empirical simulations would be greater than differences in test scores derived from beta distributions because of additional factors including differences among tutors and group dynamics. All randomization and simulations were made using the sample function in RStudio (RStudio Team 2015).

RESULTS

The combined mid-term and final test scores from 2014-2017 both had modes at 70%, negative skew and a large proportion of observed values within 60-80% (Fig 1). Overall variability around the mode decreased between the mid-term and final exams with fewer scores lower than 60% observed in the final exam than in the mid-term exam. Empirical distributions were similar qualitatively to beta distributions with shape parameters ranging from 4-5 and 2-2.5 for α and β respectively (Fig 2). Beta distributions with α and β ranging from 4-5 and 2-2.5 respectively maintained modes at or near 70%, negative skew and a large proportion of values falling within 60-80%.

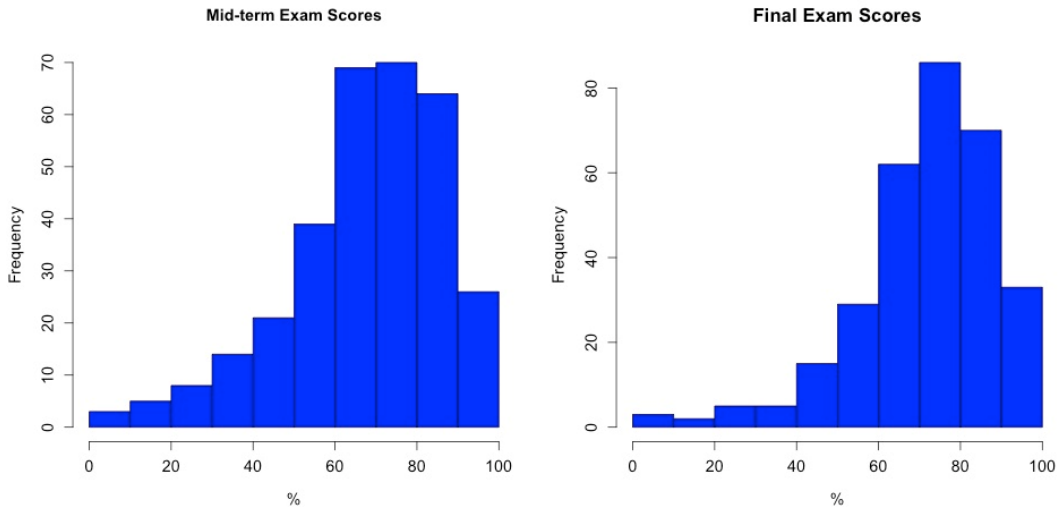

Figure 1. Empirical distribution of (left) mid-term and (right) final exam scores between 2014 and 2017 from introductory course in zoology taught through problem-based learning.

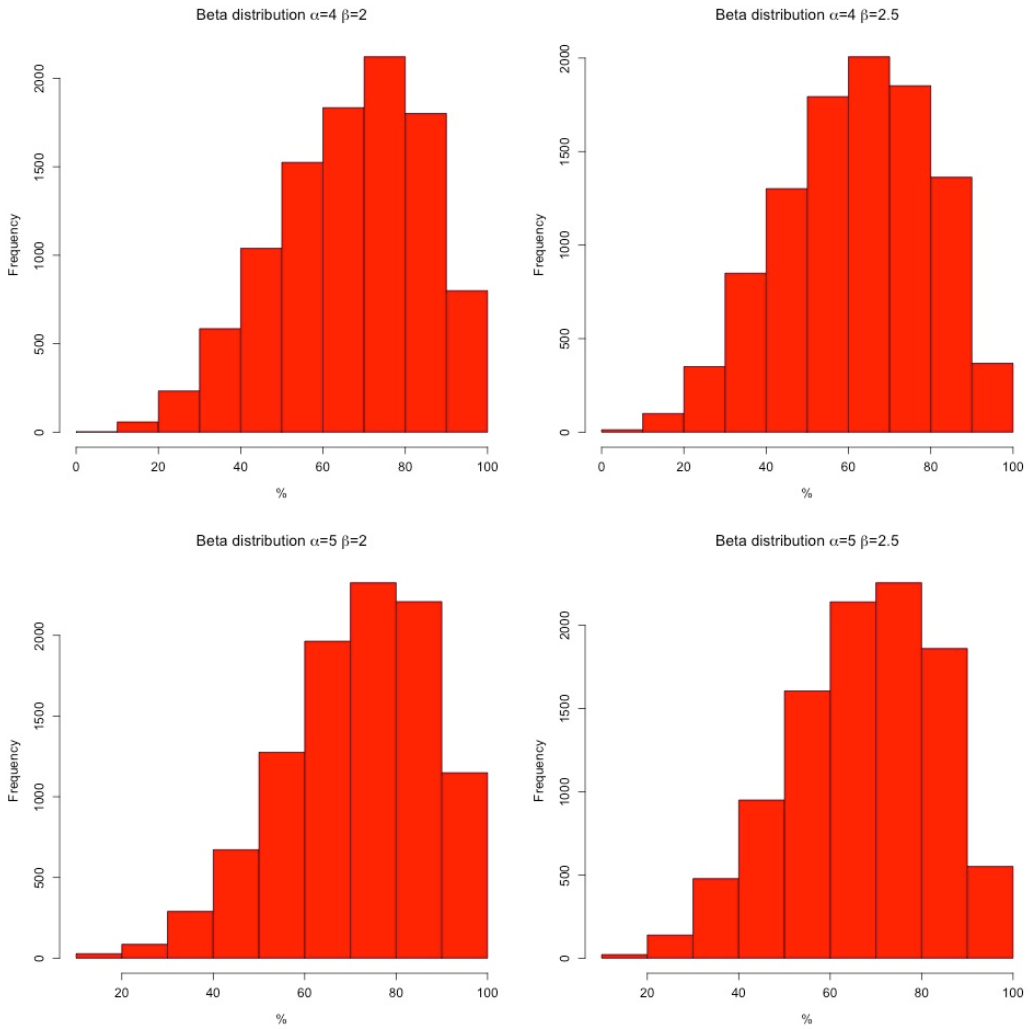

Figure 2. Histograms of 10,000 observations drawn from beta distributions with shape parameters (α, β) ranging from α=4 or 5 and β= 2 or 2.5.

Given the range of shape parameters used in our simulations, we found that average value for the maximum difference in mean test scores between groups ranged between 14.4 and 16.2 points (Fig 3). The majority of values (25-75% quartiles) for the between-group differences in test scores drawn from beta distributions fell between 11.5 and 19.2 points. Extreme differences between group means (>1.5 * the interquartile range which corresponds to a maximum difference of >25 points between groups) accounted for only a small proportion (ca. 1%) of the simulation values observed under any specific parameter combination. Extreme differences between group means were slightly larger in simulations where the β parameter of the underlying distribution equalled 2 (13 and 12 extreme value differences between groups when α=4 and 5 respectively) than when the β parameter equalled 2.5 (7 and 9 extreme value differences between groups when α=4 and 5 respectively).

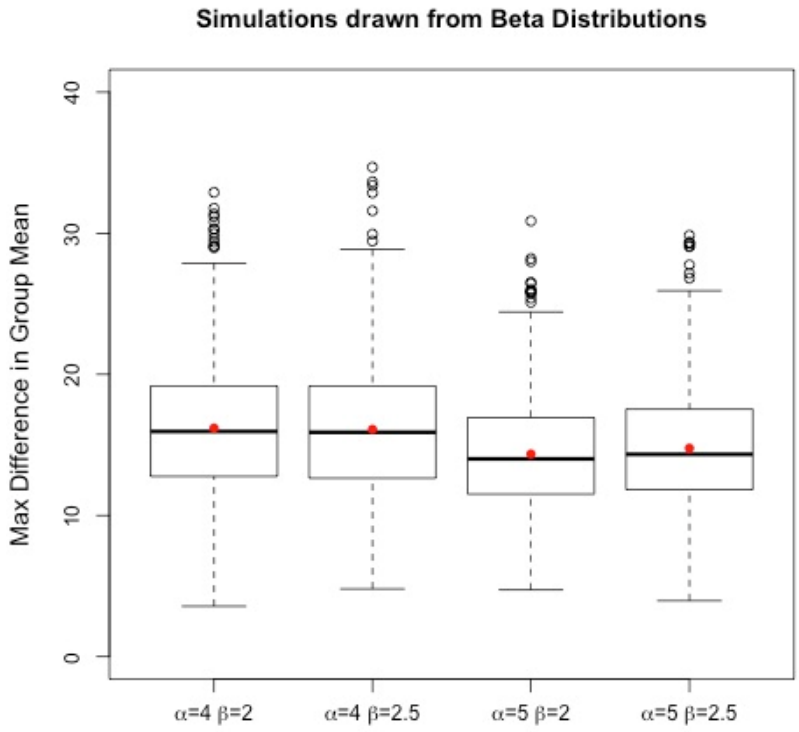

Figure 3. The maximum difference in mean test scores between problem-based learning groups from 1000 simulated cohorts of students. Test scores were drawn from four beta distributions (with shape parameters α=4 or 5 and β=2 or 2.5) and randomly assigned to learning groups. Box plots depict median values (solid black line), 25% and 75% quartile (boxes) and 1.5 times the interquartile range (whiskers). Red dots depict the mean.

When actual test scores were randomized and re-allocated to groups, mean values for the maximum difference in test scores between groups ranged from 12.2 to 18.2 for mid-term exams and from 12.5 to 17.3 for final exams (Fig 4). The overall range of between-group differences in test scores was also similar for both mid-term and final exams over the four years

examined in this study. Interquartile ranges (25-75% quartiles) for between-group differences in empirical test scores over all four years ranged between 9.6 and 21.4 for the midterm exam and 10.1 and 20.2 for the final exam (Fig 4). However, the inter-annual patterns in between-group differences of empirical test scores was different between the mid-term and final exams. Between-group differences in mid-term test scores were greater in 2015 and 2017 than in 2014 and 2016, while between-group differences in final exam test scores were similar in 2014-2016 but increased in 2017 (Fig 4). As with simulations derived from beta distributions, extreme values in simulations based on empirical data (>1.5 * the interquartile range) accounted for only a small proportion (ca. 1%) of the differences observed in any given year. However, in simulations based on empirical data, we observed 4 extreme values (out of 4000) where between-group variation in test scores was extremely low (<5 points) (Fig 4).

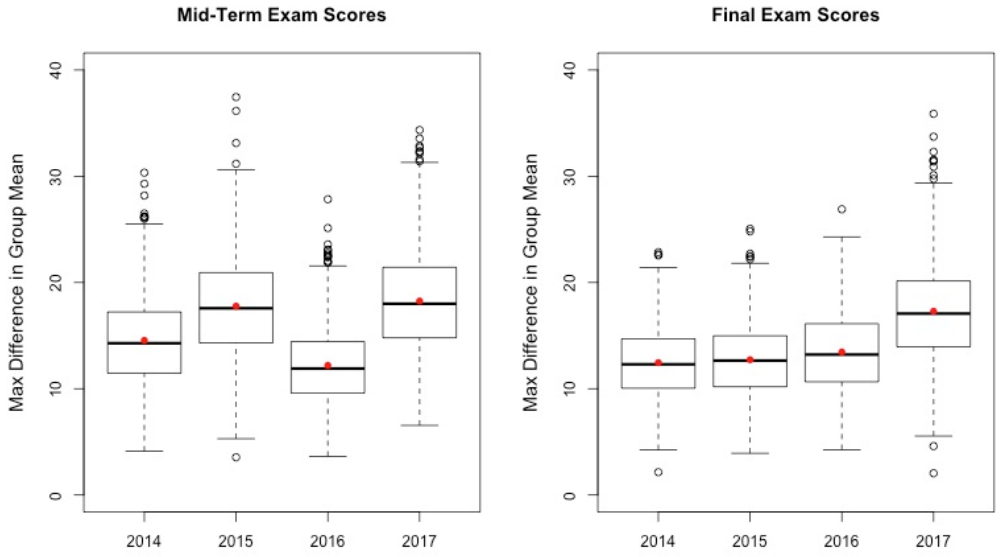

Figure 4. The maximum difference in mean test scores after randomization and reallocation of empirical mid-term and final test scores among groups between 2014 and 2017. Box plots depict median values (solid black line), 25% and 75% quartile (boxes) and 1.5 times the interquartile range (whiskers). Red dots depict the mean.

When we compared simulations drawn from empirical data with those drawn from beta distributions, between-group differences in empirical test scores only marginally exceeded those drawn from beta distributions and not in every year. The beta distribution with parameters $\alpha=5$ and $\beta=2$, had smallest between-group differences in test scores thus provided an analytically conservative benchmark for comparisons. The average difference between-groups in empirical test scores for mid-term exceeded simulations based on this conservative beta distribution by no more than 4 points in any given year and were less than simulation results in 2016. Likewise, the average difference between-groups in empirical test scores for final exams exceeded simulations from the conservative beta distribution by less than 3 points and only in

2017. In preceding years, the average difference between-groups in empirical test scores for final exams never exceeded the conservative beta distribution. Differences between simulations drawn from empirical data and those based on the other beta distributions used in our study will necessarily be less, further stressing the relative importance of the selection and group formation process on between-group differences in test scores.

DISCUSSIONS

Regardless of the parameters chosen for our simulations, significant intergroup variation of between 14.4-16.2 points was imparted solely through random assignment of students to groups. For students, this variation corresponds to the difference of 2 letter grades in typical grading scales where letter grades are separated by 10 points. For tutors, between-group variation from random assignment obscures potential differences between tutors unless differences in tutors' performance between groups exceed ca. 14-16 points. Likewise, quantitative evaluations of social dynamics within groups including student performance attributable to group size will be hampered unless it exceeds the variation inherent in the assignment of students to groups.

Incorrectly attributing between-group variation caused by group assignment to other sources of variation such as tutor performance can cause significant loss of time and result in ineffective evaluation strategies. It is our experience that tutors themselves often attribute between-group variation in test scores to differences in severity or generosity of different tutors during the correction of exams. However, it has been reported that tutors may over-rate students of the group reflecting a bonding affect (Whitfield & Xie, 2002, Cohen et al. 1993). This often leads to protracted but pointless discussions related to correction strategies. Common discussions revolve around the questions whether 'it is better to standardize corrections by having one tutor correct exams (or individual exam questions) from all groups' or 'should extremely detailed correction guides be prepared and rigidly implemented' to assure homogeneity between groups during the correction phase. Both strategies could decrease between-group variation, however these effects would be minimal. Our results suggest that after removing the between-group variation attributable to formation of groups, which under a conservative scenario based on a beta distribution with parameters $\alpha=5$ and $\beta=2$ would account for a differential of 14 points between groups, implementing additional ad-hoc correction strategies to minimize between group variation could -at best- reduce between group differences up to 4 points. In our study such minor reductions would be possible in only 3 of the 8 evaluations (2015 and 2017 mid-terms and 2017 final exam). For the remaining five evaluations the empirical between-group differences in test scores falls with the range of variation attributable solely to the group formation process.

There are additional costs associated with ad-hoc correction strategies. Strategies by which individual tutors correct exams or individual exam questions across groups do little to correct generosity or severity during the correction phase and only shift these disparities to differences in student performance on individual questions. Highly detailed correction guides often do not capture creative/unforeseen aspects in student responses-particularly in long-form essay responses to more open-synthetic type questions. It is not our position that clear correction guides and similar expectations among tutors are unwarranted during the correction phase. It is our position that these strategies will have negligible effects on between-group variation in exam scores.

One alternative is to consider a non-random assignment of students to groups. A simplistic assignment strategy would allocate students to groups based on prior performance in PBL courses. For introductory courses such as the example used in this study, prior evaluations made in PBL courses may be limited or unavailable. In cases where prior evaluations are available, there may be the practical limitation of an insufficient number of students with elevated performance that can be dispersed among groups. This has profound implications on learning strategies and group dynamics of students within a group and has been discussed in the context of behavioural ecology as the 'producer-scrounger' argument (Vickery 2013). This argument is premised on the idea that a limited number of students who contribute to group discussion during the problem or situation given to the students (ie. 'producers') promote an inverse effect by which other students contribute less (ie. 'scroungers') choosing to profit disproportionately from 'producers'. One prediction of this argument is that there is an optimal number of level of scrounging. Thus, as the number of producers in a group increases, the number of scroungers decreases. However, below the optima predicted under the 'producer-scrounger' model, scroungers should take on a greater role in class discussions and thus become producers. While this argument has been founded on ecological principals, overall performance of a group likely involves additional social dynamics among students within the group (shaming, competition, the development of cohesion and cooperation within a group). While it is intriguing to think that there may be some 'magic' formula for group assignment and group size in PBL learning continues to be an active area of research, any kind of non-random assignment can also be strongly criticized as favouring/disfavouring students depending on the criteria chosen. This highlights the need for demonstrable indicators of student performance if non-random group assignment strategies are to be adopted. If such indicators do not exist and assignment criteria cannot be justified, then tutors should learn to live with significant between-group variation in PBL courses.

For tutors and directors of PBL teaching units, the relatively large between-group variance that arrives from the group formation process presents a challenge for evaluating tutor performance. Reliance on student test scores as a metric of tutor capacity is clearly limited by the variation introduced through the formation of groups. Such strategies could only see extremes in tutor performance and would still rely on the untested assumption that variation between groups does

not occur from other sources such as group dynamics. In this context, we suggest that other metrics of tutor performance such as thoughtful evaluations made by students may be more useful.

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PBL and Mixed-Background Groups on Master´s Programmes

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ABSTRACT

This article presents the main findings of an applied research project, which studied student experiences of the challenges and opportunities of Problem-Based Learning (PBL) in two master programmes (MPs) at Aalborg University (AAU) characterised by diverse student groups, who bring different educational backgrounds, skills and experiences to the table. Research shows that PBL holds a potential for integrating and promoting learning outcomes for diverse student population, but also that heterogeneity can have negative influence on group dynamics and collaboration central in PBL, but how students experience this is under-researched. The investigation shows that diversity in terms of age differences and varieties in educational backgrounds are experienced both as challenges in teaching situations, but also as an opportunity to increase student learning over time. The study concludes with recommendations for practical alterations of the introduction to and conditions for the PBL model.

CHALLENGES TO HIGHER EDUCATION PROGRAMMES

In the 2000s, and especially in the wake of the financial and economic crisis that began in 2008, intake of students to higher education underwent a virtual explosion, educational attainment being seen as an important pre-requisite for economic growth (Caspersen and Hovdhaugen, 2014; Arvanitakis, 2014, p. 737). The resultant high and, often, growing

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student numbers make for groups with widely varying pre-requisites for academic work and for decoding the academic environment (Stafseng, 2009; Dale, 2009, p. 474). Student populations are now more diverse in terms of both ethnic, cultural, language, age, social class, gender and prior educational training backgrounds, which makes it important to understand challenges and opportunities connected to student heterogeneity and diverse learning environments (Singaram et al., 2010). Diversity, however, is an elastic concept, since it refers to a range of human differences in characteristics, qualities and conditions, for example observable differences such as physical function, age, ethnicity, gender and race, but also not directly observable differences in values, socioeconomic status, education, skills and knowledge (Singaram et al., 2010, p. 298; Dan and Mino, 2016, p. 39). Furthermore, these differences are not mutually exclusive, but are often combined and associated with each other, e.g. race may be associated with socioeconomic status.

In the context of higher education, collaborative approaches such as problem-based learning (PBL) have presented themselves as an opportunity to enhance learning among diverse students (Ellis and Gabriel, 2010). Looking closer at PBL, there is not one single definition or understanding of the concept. However, there is some agreement that common principles are that student learning and curricula should be organised around problems rather than disciplines, and that collaboration in small groups facilitates social as well as academic learning and thus prepares the students for handling complex problems in real life (Li, 2013, p. 178). Research has emphasised the model's problem-oriented approach, the focus on integrating and combining different academic disciplines and on collaborative learning in groups as holding a potential, when it comes to integrating and creating learning outcomes in diverse student populations (Singaram et al., 2010; Busse and Krause 2015).

However, in the research literature on PBL there has been much debate about the effects of student heterogeneity on small group work in project- and problem-based learning (Cheng et al., 2008, p. 205). Significant work has been done on understanding how different factors such as gender, age, ethnicity, intellectual abilities, educational experience, study strategies, study hours and socioeconomic background influence the interplay between group members, their learning processes and the overall learning outcome (Khan and Sobani, 2012, p. 123). Studies have shown that student heterogeneity and diversity have positive effects on small group learning outcomes. It is highlighted that group inhomogeneity brings diverse perspectives to the discussion, which enhances learning, and that students working in heterogeneous groupings learn from their differences and thus becomes better prepared for their future professions in diverse and complex societies (LaPrairie, 2009; Khan and Sobani, 2012; McLean et al., 2006; Mills et al., 2007; Singaram et al., 2008; Sinagram et al., 2010). However, there are also studies, which point in other directions. For example, Cheng et al. (2008) found that group

heterogeneity was not a determinant factor in students' learning efficacy. Instead the quality of group processes had a fundamental role to play in student learning. Also, a study by Robinson (2016) has showed how inter-generational issues create positions of power in the group that is detrimental to deep exploratory learning – an important principle of PBL. Other studies point to the fact that "collaborative heterogeneous learning has two sides that need to be balanced. On the positive end we have the 'ideology' behind mixing diverse students and on the negative the 'practice' behind mixing students" (Sinagram et al., 2010, p. 297). The conclusion here is that simply placing students in heterogeneous groups without any support in how to handle differences in e.g. language, academic preparedness and perceived status factors is unconstructive and ineffective (Sinagram et al., 2010).

Thus, to sum up, research results on PBL and student diversity are inconsistent, and furthermore it is less clear in the literature, how students experience PBL in student populations that are diverse when it comes to educational background and professional experience – not only in connection with project work in small groups but also more broadly in an PBL-oriented educational practice.

This article presents the findings of an applied research project that studied how students experience the challenges and opportunities of working with PBL in mixed-background MP in order to identify ways of resolving issues related to this type of diversity, that is – students who are diverse when it comes to professional and educational backgrounds and experience. Using an inductive, qualitative approach and by making use of focus group interviews we have explored the following research questions in depth:

- How do students experience the challenges and opportunities of PBL in mixed-background MPs?
- What suggestions do the students have for solving the challenges, they experience (if any), and how to make improvements to the introduction and conditions of the PBL model as it relates to student diversity?

METHODOLOGY AND EMPIRICAL MATERIAL

As outlined above, the aim of the study was to shed light on students' experiences of the challenges and opportunities of PBL in mixed-background MPs. We chose to conduct focus group interviews with graduate students on their 1st semester of two MPs based at Aalborg University: The MA in Social Work (social sciences) and the MA in Learning and Change Processes (humanities). The choice is based on the fact that the graduate students enrolled in the two MPs vary widely in backgrounds, skills, bachelor degrees, age and professional experience, which will be elaborated below. Furthermore, both MPs

have attempted to promote and develop different approaches to PBL on the introductory semester. This is in line with the overall strategy of AAU, which has had a strong focus on PBL since its beginning in 1974. The pedagogical linchpin of PBL at AAU is self-governed group work organized around a problem-based project and supported by a supervisor. A key principle of the model is that students learn best when applying theory and research-based knowledge in their work by studying and possibly solving an authentic problem – a problem that has societal and practical relevance (AAU, 2016). The problem-based focus requires of students to combine a variety of perspectives and knowledge (theories, methods, scientific disciplines, practices) in an interdisciplinary problem-solving learning process (AAU, 2016). Overall, this has traditionally been regarded as the basis for producing highly reflective, independent and competent students and bachelor's or master's graduates.

The two MPs prepare students for roles such as lecturing in higher education, training of social workers, nurses or educators, or in other training roles in the social professions or the voluntary sector, leadership, coordination, development and innovation work, consultancy and other cross-functional roles in development in the public or private sector (MA in Learning and Change Processes, 2018; MA in Social Work, 2018).

The students gain grounding in scientific theory and methodology enabling them to take on research, analysis, evaluation and development responsibilities in fields related to learning, education and social work (MA in Social Work, 2018a). Both programmes have a markedly interdisciplinary structure and strive both to integrate different disciplines and to build bridges between traditional academic theory and methods and skills directly relevant to a practice field (Ejrnæs, 1998, p. 38). The MPs are also similar in that the students are not being trained for a well-defined job market (as opposed to e.g. engineering, law or psychology students). They therefore – to a higher degree – need to define, build and formulate their own professional profiles and career options.

These complexities amount to a pedagogical challenge of developing an integrated discipline in which students can relate *both* to practice *and* apply scientific theory and method. The following section will identify and document in greater depth the types of diversity found among students on the MPs.[1]

[1] The student data are acquired from AAU Economy and Statistics Department and analyzed by the authors of this article.

DIVERSITY IN MIXED-BACKGROUND MP GROUPS

The students enrolled in the MPs have widely varying educational backgrounds. To get a picture of the diversity in the students' educational and professional backgrounds and age, we are going to present the 2016 cohort as an example using quantitative data from both MPs. Figure 1 shows the composition of the students' bachelor degree types.

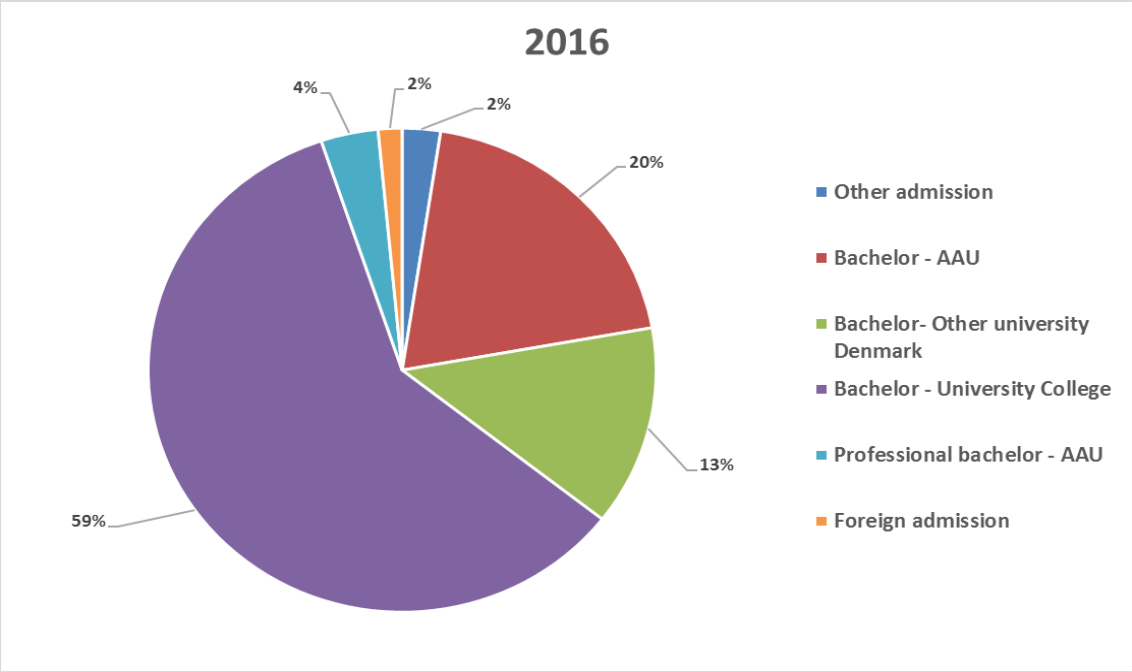

Figure 1: All students (N: 329) admitted to the MPs, broken down by bachelor degree type, 2016

As the chart shows, students with a professional bachelor degree from a University College by far make the largest group – 59 % of the students in 2016 had this type of degree. The second largest group of students (20 %) had an academic bachelor degree from AAU, and 13 % of the students in 2016 had an academic bachelor degree from another university. A minority of the students – 4 % – had a professional bachelor degree from AAU. Thus, a total of 24 % of the student had experience with PBL from AAU and the large majority of came from educational programmes that have not implemented a PBL approach. This means that the students bring with them different experiences of group work and PBL.

The differences in bachelor degree are reflected in diversity in professional experience, which is illustrated in table 1.

Table 1: Student backgrounds, SW and LCP 2016

Student background	Students, SW, in percent (n=160)	Students, LCP, in percent (n=169)
Social worker	37	2
Nurse	15	1
Nutrition and Health	-	14
Occupational therapist	5	-
Pedagogue	2	20
Public Administration	1	8
Prof. BA	2	6
Teacher	-	13
BA Social Science	16	11
BA Humanities	16	21
BA Other[2]	3	2
Unknown	3	2
Total	**100**	**100**

Table 2: Student backgrounds, SW and LCP 2016

Table 1 shows that most of the students from MA in SW are trained social workers: 37 % in 2016. The next largest group – 35 % – has a bachelor's degree in social science, the humanities or another academic bachelor. There is also a relatively large group – 15 % – with nursing training, while 10 % are trained as occupational therapists, pedagogues, in public administration or other types of professional bachelors. In the LCP MP the largest group of students also has a bachelor in the humanities, social sciences or another academic bachelor (34 %). The second largest group has a professional background as pedagogues (20 %). A relatively large group of students has a professional background in nutrition and health (14 %), as teachers (13 %) or in public administration (8 %). Put together 64 % of the students in the LCP MP have a professional background, rather than a strictly acadamic. This is the case for 62 % of the students in the MP in SW. This obviously means that a large number of students have work experience from different professions, and may have been away from academia for several years. This also results in significant age variation among the students, which is illustrated in the figure 2 below.

[2] This category contains other bachelor's degrees such as cross faculty degrees, for example, within health promotion or communication.

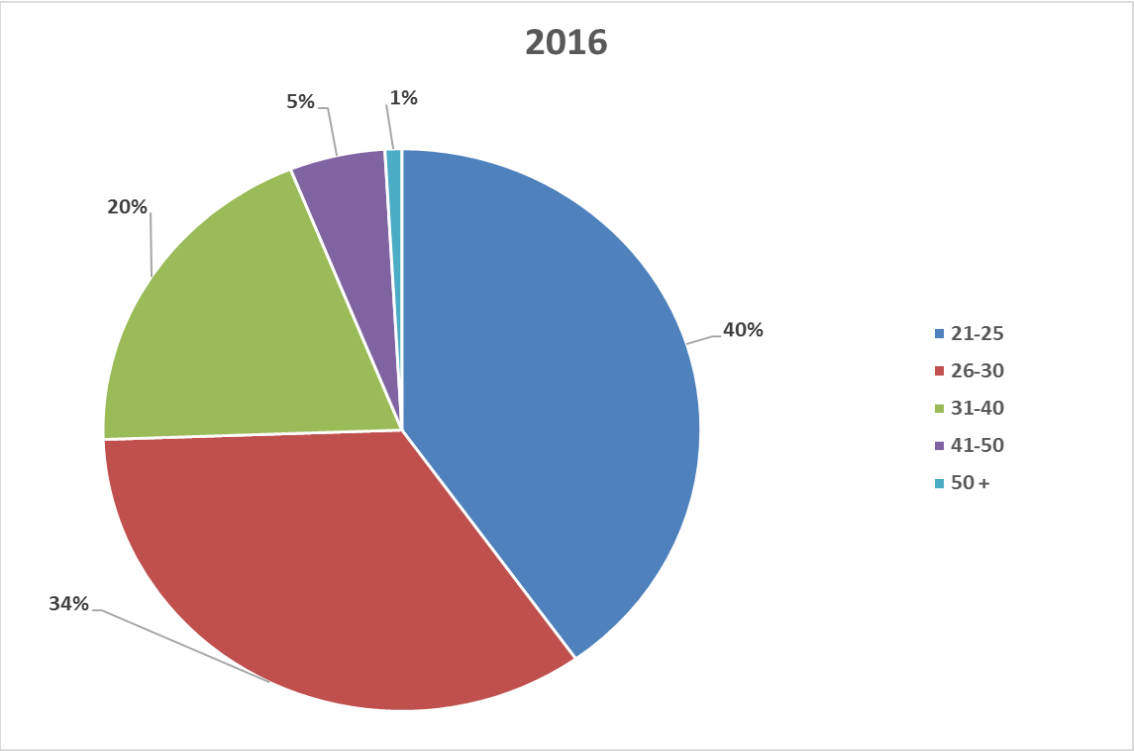

Figure 2: Age distribution among SW and LCP students in 2016

In 2016 40% of students in the MPs were aged 21-25, 34% were aged 26-30, 20% were aged 31-40, 5% were 41-50 years old and 1% were 50 years old or more. Although the youngest age group was the largest in 2016, about half (54%) of students were aged 26-40, while a not insignificant proportion - 6 % - were aged 41 or older. The students thus exhibit a wide range of ages, with the student body divided into a large group of young students aged 21-25, an even larger group of 26-40-year old, and a smaller group aged 41 or more.

Looking at the gender distribution of the two MPs, a clear picture emerges of female students making up a large majority. Women thus accounted for 86% of the students in 2016 on the MP in SW, and 87 % on the MA in LCP the same year. The MPs are thus relatively homogeneous as regards gender. This study did not include data on the students' ethnic backgrounds or socio-economic status, but we know from earlier research that these are important dimensions of diverse learning environments.

We can conclude that the typical student on the MPs is a woman in her thirties with a professional bachelor's degree, but overall the MPs are marked by a high degree of diversity, when it comes to age and professional and/or academic experience and knowledge. This also means that the students are in different stages of their life; they may or may not have families, children and/or a continued connection to the labour market,

while they are studying. Differences in life experience and life stages can strongly impact learning, as evidenced by e.g. Illeris (2005), and thus it becomes important to investigate, how the students experience the challenges and opportunities of PBL in mixed-background MPs, and how to make improvements to the PBL model as it relates to student diversity. In the following we will elaborate on how we selected informants for the focus group interviews, and how the interviews were conducted.

SELECTION OF INORMANTS AND METHOD

As mentioned, we chose to conduct focus group interviews with students just after they had completed the 1st semester of the MPs. During this period, many of the students are introduced to PBL and work in project groups for the first time in their educational life, while others have much or some experience with PBL and group work.. Research has shown that student diversity may be perceived as a greater challenge in the short term when working with PBL in a new learning environment, but in the long term heterogeneous groups lead to comparable or better performance (Khan and Sobani, 2012, p. 124-125). Therefore, the introduction of PBL in the first semester is central, when it comes to creating a shared sense of academic affinity and for integrating the students into the MPs. Related to this, data from the MPs show that drop-out rates are highest in the first year, emphasizing the importance of the introduction phase for programme outcomes.

We conducted two focus group interviews: one with three LCP students and one with six SW students. The focus group interview form was chosen because it gives students the opportunity to support or debate each other's answers and reasoning (Launsø and Rieper, 2006). There is agreement in the methodological literature that the purpose of focus group interviews – contrary to individual interviews – is not to go into depth with individual answers, but to elicit dialogue and the participants' response to each other's statements and opinions (Justesen and Mik-Meyer, 2010, p. 79). It is a special trait of focus groups that the participants are encouraged make 'taken for granted'- norms and preconceptions explicit, because the participants will debate with each other and ask each other questions in the course of the interview (Justesen and Mik-Meyer, 2010, p.79).

This form of interview also highlights the role of the moderator. According to Lezaun (2007, p. 138), "the role of the moderator is thus to *provoke* preconceptions that would suit her research purposes". Lezaun (2007, p. 138) argues that informants will always try to act in accordance with what they think is expected of them in the interview-situation. This makes it important for the moderator to manage the informants' expectations "so as to generate nondirective outcomes that are conducive to the research" (Lezaun, 2007, p.

138). This reflection was particularly important in relation to our research process for two reasons, since the focus group interviews were conducted by two members of the research team, who are also supervisors – but not teachers – on the MPs. This may lead the students to be overly oriented towards what is expected of them, because they may perceive the moderators not as neutral, but as representatives of the MPs. The role expectations connected to being a student and a supervisor respectively, may contribute further to this. Thus, the moderators continually had this in mind by asking non-directive questions, but also questions that would invite the students talk about the more negative experiences of PBL and diversity in the MPs.

The informants were recruited by an email explaining the research focus and encouraging them to participate in the focus group. This resulted in a LCP focus group with three students: two with a professional background as a pedagogue and a physiotherapist respectively and one with a bachelor's degree in sport science, and a SW focus group with six students: two with a bachelor in sociology, two with a professional bachelor in social work and two with a professional background as a pedagogue and a nurse, respectively. Three of the nine students were men. We do not know how they are placed in the age spectra of the MPs. Thus, this group of students can be seen to represent the diversity in the MPs, even though they have not been selected, but have volunteered to participate on their own initiative. It is important to be aware, though, that this way of recruiting informants present a possible bias, although not one we have any certain knowledge of here, since it is likely to sample a certain type of students, e.g. students who are more engaged in their studies, and/or may be motivated by the opportunity to express experiences that are overly positive or negative compared to others students' experiences. In order to counteract this potential problem, we have chosen to include qualitative comments from the standardized student semester evaluation that is relevant for describing, how the students experience the challenges and opportunities of PBL in the mixed-background MPs.

The focus groups were semi-structured and an interview scheme was designed to explore, how the students experience both the introduction to and courses in PBL, the long-term process of project and group work in the first semester and the opportunities and challenges they had faced. The moderator introduced the purpose of the research project and of the focus group and informed the students that they would be fully anonymised in the final report, and that they were able to withdraw their consent at any time. The interviews lasted approx. 60 minutes each, and they were audio recorded and transcribed in their full length.

The analysis was made with an inductive, thematic approach. This means that the transcripts have been read and reread many times in order to identify patterns in the

students' experiences. By an inductive coding of the material 'staying close' to student narratives, four common themes of relevance to the research questions were identified

We will now look in greater depth at the students' perceptions and experiences of PBL and diversity and the challenges and opportunities of PBL in the first semester of the MPs.

STUDENT PERCEPTION OF STRENGTH AND CHALLENGES CONNECTED TO DIVERSITY AND PBL

In table 2 we have displayed the main themes found through analysis. In the following, each theme will be described and illustrated by student quotes.

Opportunities	**Challenges**
Development of collaborative skills	Differences in academic background and skills create unequal status and poor group dynamics
Difference as an offset for academic development	Diverse backgrounds and disciplines as a challenge to teaching
Recommendations: *Teachers should actively try to make students aware of difference and support the groups in handling diversity* *Teachers should facilitate group-formation*	

Table 2: Summary of main themes and recommendations[3]

Development of collaborative skills

The students emphasize that through project work in small groups they gain experience of collaboration and acquire skills of problem-solving with others that are important for their future professional life:

> *I think it's really great to have learnt to work together both in stressful situations and when you're hoping something goes well. And with something that you want to go well, something you want to be your own, but where you still have to reach agreement with others. There are really a lot of problems that you confront, when you are cooperating, and when you have done it for several semesters, you really*

[3] This table is inspired by Sinagram et al., 2010, p. 302

> *develop, I think! Then you are ready for managing yourself in 'real life'.* (Student, LCP)

It is a common experience that the pressure of working together with others within a limited timeframe with the aim to produce an academic product – the project report – provides the individual student with possibilities of developing their personal and collaborative skills, and that these skills are developed through the course of the MP:

> *Looking at my first semester and until now, I'm much easier to collaborate with, because you've learned to 'take things in' and to work together. I'm happy that I've learned this now, when I have been confronted with the problems, instead of waiting until I enter a workplace. This is worth just as much as all the theories, I've learned. It's great!* (Student, LCP)

In relation to this the students perceive diversity in the groups – that is differences in age and backgrounds – as a reflection of the diversity they will meet in the workplace, and as an opportunity to develop their collaborative skills further:

> *There's just a really wide variation in age and education – in everything, really! It's just very mixed. But even so, I think you manage to accept that there is that difference. So maybe I'm towards the rather younger end of the big group, but if I'm sitting and working with someone who's maybe 50, I actually think that's just great, because you do learn things that way. And you have to do that when you go out into the workplace.* (Student, LCP)

The ability to 'accept difference' and work closely with people who are at a completely different stage in their lives, and who have different social experiences, is seen by the students as an important career skill for employment success later on. The advantage of the PBL approach here is that because it builds on the joint effort of group members to achieve a common outcome it has the potential to facilitate the interaction of different lifeworlds and learning strategies. Thus, these experiences point to the opportunity of PBL in mixed background MPs.

Difference as an offset for academic development

Students also emphasize the opportunities for academic development when working in groups with a diverse composition. They point out that in addition to learning how to collaborate, different approaches and ways of looking at issues also contributes to academic learning:

> *I'm thinking of the whole social and collaborative thing, but I think you get more academic development, too. I get the feeling that being allowed to debate and look at things from different angles, that's the advantage of a large group. The fact that there are many different angles you can take…there is also an academic development aspect to it, which I wouldn't have been able to get on my own.* (Student, LCP)

The fact that the students in the project groups do not only have different academic backgrounds, but also different professional experiences adds further to developing an authentic problem and creating interdisciplinary knowledge that has relevance for practice – the official purpose of the PBL-model:

> *Seen in relation to groups in sociology* [bachelor education]*, where we…well, it was more academic. It was young people, maybe with less experience from the labour market, but nevertheless you had to relate to other people's ways of understanding the curriculum and different dynamics. But here* [MA in SW] *there is the advantage that you also get to know other professions' view on problems. I think, I have learnt very, very much from that.* (Student, SW)

The students therefore highlight the possibility to get an inter-disciplinary perspective and join cross professional experiences in the solution to their self-identified practical problem. There is thus a potential to push reflection further than in a more homogenous setting, as presumptions and taken for granted knowledge that the students bring with them to the group interaction are challenged in a diverse MP. However, even though the students highlight the possibilities for learning, when working in groups with mixed backgrounds, they also experience challenges that can hinder group collaboration and learning processes. This will be the focus of the next section.

Differences in academic background and skills create unequal status and poor group dynamics

Intra-group diversity also gives students cause for concern. Student evaluation questionnaires from both MPs show that group work can be experienced as challenging and even stressful. There may be several reasons for this, but student evaluations show that the educational and professional diversity within the groups can be a source of pressure. Poor group dynamics and a lack of mutual understanding seem to be sparked off by differences in academic background, skills and orientation:

> *We are so different and the 'older' ones, who haven't studied for a long time, are REALLY an obstacle in the collaboration, because they want to write about practical issues, and in this programme we have to be theoretical. It would be nice,*

> *if they had a course in how to write a project before they started*. (evaluation, student, SW)

And:

> *I think it is reprehensible that you [the MP] cannot help or make a course for those, who haven't done analysis for maybe 10-15 years. You cannot teach them this, write a project and read the curriculum at the same time!* (evaluation, student, SW)

In these cases, the perceived negative differences in skills between students with a traditional academic background and orientation and students with several years of experience from the profession, hinder group collaboration, integration and learning processes central to PBL. The students' statements also express a status hierarchy, where theory and academic skills are regarded as superior to practical and professional experience. Thus, students with an academic background sometimes find it challenging to collaborate with other students whose learning approach is less theoretically grounded. This can hinder learning, understanding and development of a shared language:

> *We spent around one and a half to two months learning to talk with each other. Learning to understand each other, saying a sentence and really understanding that sentence. It was absolutely awful! I have never experienced anything like it.*
> Moderator: *That's a long time…*
> Student: *It was crazy! Then somebody enters, and they say something, and you think: I have never heard that word before! Yes, yes! And then they begin to explain it, and no, I still haven't heard that word before!* (…) *It was because we had three social workers and two with an academic bachelor in the group. The two of us, who had an academic bachelor, we often understood each other. And then there was the other three, who talked a lot about legal paragraphs, and they talked about social reality, where we were more like: yes, but we have to integrate this theoretically! On the one side it was very philosophical and more practical on the other side, and we didn't understand each other. These two different contexts*. (Student, SW)

The social work MA student here makes a clear distinction between the 'practical social workers' in the group, who talk about legal paragraphs and 'social reality' and the 'philosophical academics', who are able to reflect on a theoretical level. For some reason this hierarchy in what is regarded as legitimate knowledge is expressed more clearly by the students from the MA in Social Work than students from the MA in LCP. As we have illustrated, the proportion of students with a professional and academic background respectively, is almost similar at the two MPs (slightly more than 60 % have a

professional background), but there are differences in the professional profiles of the students enrolled in the two MPs. Compared to the MA in Social Work, where almost 40 % of the students are trained social workers, there are no social work professionals in the MA in LCP, where almost half (47 %) of the students have a professional background as e.g. pedagogues, teachers or in nutrition and health. These differences in professional profiles across the two MPs can contribute to explaining the difference in assessment of the qualities of more professionally experienced fellow students. For example, teachers are professionally trained in the context of the educational system and in acquiring and communicating new knowledge, which may enable them to adapt more aptly to the standards of the academic setting and acquire 'a sense for the game'; an academic habitus (Bourdieu 1984). However, on the grounds of our empirical material, we are not able to cast a light on these differences *among* the students with professional profiles related to pre-requisites for decoding the academic environment, which would be an interesting subject for further research.

However, diversity is also related to differences in experience with AAU's problem-based learning model:

> *…[W]e have very different levels of experience with PBL, you see. Some people have taken their BA here at Aalborg University and have done six PBL projects; there are others who have never ever worked the way people do at this university, because there are also people with professional bachelor's degrees.* (Student, LCP)

Writing problem-oriented projects in groups with diverse backgrounds and experience with professional or academic work can lead to poor group dynamics, status divisions and polarization, which hinders the establishment of a common academic identity and language. In addition to this, mixed backgrounds give rise to challenges in relation to course teaching.

Diverse backgrounds and disciplines as a challenge to teaching

Students may also see diversity in academic backgrounds as a challenge in lectures and seminars, because it makes it difficult for the teachers to assess the knowledge base of the individual student and target their teaching. In the lecture room there may be students, who have almost no knowledge of subject areas related to e.g. social work, but extensive knowledge about and experience with methodological aspects of academic work and vice versa. Thus, elements of teaching will be pure repetition for some students, while challenging others. A student describes diversity as an obstacle to more advanced study:

> *I think our diversity is a bit of a challenge in teaching situations, because there are so many of us, and we have no knowledge in common at all. So, this semester, there was quite a feeling that there was some kind of basic level that had to be covered. And there are some people who knew it all to start with and there are some, who didn't know anything at all to start with. So, it was very difficult in terms of teaching, I think, because we were so different...* (Student, LCP)

According to the students, the teachers at the first semester often encourage the students to mix across educational backgrounds, when doing exercises in the teaching seminars. However, there are barriers to interaction that are not easily overcome by this teacher's request:

> *They often say: 'now, make groups, where you are not from the same profession!' But if they don't do more than that, then we don't do it. That's not my experience. No-one says: 'well! If I'm sitting together with four from my sociology-education* [bachelor], *then I will not go together with somebody else, if I can see that everybody just goes together with the ones, they are sitting next to* [people with similar backgrounds]' (Students, SW)

Again this points to challenges in the students' experiences with PBL in mixed background MPs – in this case in teaching situations. Students tend to interact with students that are similar to themselves in terms of educational backgrounds, and this contributes to maintenance of the divisions between academic and professional bachelors and hinders integration of different perspectives and knowledge.

We can thus conclude that the students see great learning potential in PBL in mixed-background MPs, but they also experience challenges related to diversity in project work and teaching. In some cases, differences in academic and professional backgrounds produce divisions and poor group dynamics that hinder learning and creation of a common language and knowledgebase.

RECOMMENDATIONS

Teachers should actively try to make students aware of difference and support the groups in handling diversity

Teachers and supervisors in mixed-background MPs should be aware of these challenges connected to diversity and actively support the valuation of different forms of knowledge, perspectives and contributions to teaching and group project work - academic as well as

professional and practical. This is about presenting diversity as beneficial to students' learning and development of professional and collaborative skills and speaking explicitly about the strengths of diversity in a PBL context. It is also about supporting the groups in handling diversity by addressing power issues and conflicts among the students that create poor group dynamics and hinder learning (cf. Sinagram et al., 2010, p. 305). This can be a difficult task, and training supervisors in dealing with heterogeneous groups is essential. The study also indicates that MPs with diverse student backgrounds have to facilitate collective and individual reflection on learning strategies and learning styles. By making the students more aware of their own learning style, they can develop strategies for turning differences into synergies.

Teachers should facilitate group-formation

The students suggest that teachers spend time supporting and facilitating group formation and 'matchmaking'. The interviews show that working together with others within a limited timeframe with the aim to produce an academic product creates pressure, and the students welcome more time to get to know each other without this pressure:

> *I think it is a challenge that there is not more time in the course, before we write the project. You could put a bit more effort into throwing us into working more differently. You are placed in study groups from the start, and you work in them until the project groups are created. But there are so many people in the class that I haven't tried cooperating with, and I don't know their ways of thinking and what they are interested in. And in my eyes, much of project work is interest and passion for the subject, you are writing about. But a lot of it is also getting to know more about who you can cooperate really well with…where it's just working!* (…) (Student, SW)

A concrete suggestion is writing a small "test project", e.g. a project synopsis, in groups that are put together by the teachers, before forming groups and writing the PBL-project for the exam. This would support a higher degree of integration in the class and diversity in interaction experience.

CONCLUDING DISCUSSION

Student experiences relayed in this applied research project support the findings of Sinagram (2010) in that the students experience diverse backgrounds in the PBL setting as both an opportunity and a challenge. They experience that diverse backgrounds enable them to practice collaborative skills and that bringing together different lifeworlds and experiences can be a career improving competence. It is of course here important that the

MPs under study are both directed towards the interaction of academic knowledge and practical skills. Although collaboration across age and gender differences must be expected within most career paths, both of the MPs under scrutinisation here point to career opportunities in more diverse environments, developing social work and further education and learning processes in often cross-sectoral settings. This is not simply a question of respect for the age or longer experience of fellow students, but how these experiences are put to work in the solution to the groups' self-articulated research questions. However, the students also indicate that overcoming status differences relating to differences in academic backgrounds or work experience require support from the professional learning environment.

In relation to this, a recent study shows that a large proportion of students from the MA in SW "feel uncertain about the academic expectations and whether they master the subject matter sufficiently", and that "perhaps their supervision is insufficient for responding to individual concerns when it is group based" (Monrad and Mølholt, 2017, p. 82). These experiences indicate that the students react to differences in academic experience and abilities to appropriate academic codes (Bernstein, 1996). In this study, these differences are most clearly expressed as a hierarchy between students, who think 'theoretically', and students, who are more 'practical' – a hierarchy that may also reflect perceived differences *between* students with different professional backgrounds, e.g. teachers and social workers, and their abilities to appropriate academic codes. This would, however, be a question for further study. Importantly, this study shows that these are challenges that are experienced in the lectures and seminars as well as in the group work settings. They relate how students are more likely to choose the easy way out and seek collaboration among fellow students that are more like themselves if the processes of group formation and collaboration are not probably facilitated. Differences in abilities to appropriate academic codes for learning is a common problem across further education settings whether or not they have adopted a PBL approach, but the findings above might indicate that the PBL setting have the potential to overcome such differences if managed in a way that explicitly takes on such challenges.

Working on a self-articulated research question is already a challenge for many students who struggle with the demands of supported self-managed learning in the PBL learning environment. Our study shows that course conveners and lecturers must highlight both potentials and challenges of differences in academic backgrounds and work experiences. By bringing the challenges out in the open as something that the students actively must position their own learning strategy in relation to will improve the chances of capitalizing on the diversity. This should be a constant facilitated reflective process and not something that starts and ends with the introduction to the PBL method at the beginning of the MPs.

This demands that resources are directed in MPs with diverse student background to facilitate these processes.

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Teaching Critical Thinking Within an Institutionalised Problem Based Learning Paradigm – Quite a Challenge

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ABSTRACT

This paper reviews the design of a 'Professional Inquiry' course taught for four years to Information Studies students at Aalborg University, Denmark, within the pedagogical paradigm of Problem Based Learning (PBL). The course teaches students how to formulate research questions and scientific problems, and determine what is worthwhile knowing within the field of informatics. Assuming critical thinking to be an integral part of PBL, and PBL being an integral part of our university's pedagogy, we did not anticipate the conflicts which surfaced from our four years of teaching this course, conflicts which are putting students' cultivation of critical reflection skills at risk: (1) while project work revolves around real-world problem-solving, critical thinking requires inquiries into what we already know, the ways we know, and why we know and not know, hence implying continuous reformulation of the problem under research; (2) while making critical thinking the subject of a course gives this skill focal attention in a fixed period, it by the same time may give students the impression that it is something to get over with; (3) while to think critically require time to review past accomplishments, the continuous pressure to deliver on time invite students to shortcut reflection time; and (4) while teaching hours allocated to curriculum keeps being cut, students' needs for being meet where they are, keeps growing.

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INTRODUCTION

This paper is a self-reflection of four years of designing and teaching a graduate course entitled 'Professional Inquiry", a 5 ECTS meta-course to students of the Information Studies master's programme at the Faculty of the Humanities at Aalborg University.

A review of our teaching experiences shows that the university students of today's occidental world, in our case Denmark, face considerable pressure to deliver, get good grades, do as told and become individual successes in all aspects of their life to the extent that it jeopardises the pattern which should connect their items of learning and cultivate their ability to tell what is worthwhile knowing. Hence, we bluntly ask whether the institutionalised Problem Based Learning (PBL) paradigm allows students to cultivate their critical thinking skills. We are aware that finding ways to develop critical thinking is neither a simple nor an easy task. It has been a concern for educators since Plato, and we remember Gregory Bateson's (2002) famous warning in a letter to his fellow regents of the University of California: 'Break the pattern which connects the items of learning and you necessarily destroy all quality' (p. 7). Nevertheless, even though our material for posing this statement is limited, we find that the question of how to best support students' cultivation of their critical thinking skills require more attention, not least within an institutionalized paradigm of PBL claiming to have critical thinking as its DNA.

Graduate education forms a doorstep from schooling to professional practice. At work, you bring what you learned in graduate school to problems in your professional practice, situation by situation and day by day, and you learn how to improvise. The journey from being a student in higher education to becoming a professional practitioner with an academic background has been described as a journey from being taught and examined in espoused theory at university to becoming a reflective practitioner (Schon, 1983), passing – while gaining situated experience – from the level of a novice, who exercises the rules of espoused theory rigidly, to higher levels of situational application of theoretical knowledge (Dreyfus & Dreyfus, 1986). Teachers involved in graduate education, who want to prepare students to become reflective practitioners in their work life, must engage in their teaching with both sides of the doorstep to help students to develop a sustainable ability to determine what is worthwhile knowing.

Aalborg University, which was inaugurated in 1974, was founded on the idea of putting academic knowledge into societal perspective. The founding mothers and fathers chose the paradigm of PBL and Project Organised Learning (Dirckinck-Holmfeld, 2002) as its pedagogical foundation. Over the years, however, efficiency policies, standardisation and quantitative measures have put pressure on the idea of contextualising theoretical knowledge through dealing with real-world problems. Nevertheless, Aalborg University continues to use PBL as not only *an institutional frame* for the students' study work, in

that all major exams take their point of departure in study groups' reports from problem-oriented project research, but also, and consequently, as *a social frame,* since students are required to collaborate on these projects.

There is an ongoing debate at Aalborg University regarding the potential discrepancy between teaching and learning espoused theory and the pedagogical paradigm of PBL, and regarding the teacher's role in helping students to situate the academic knowledge in real-world problems in ways that prepare them to become reflective practitioners. Such preparation is an endeavour to which cultivating critical thinking and critical reflection and developing the ability to repeatedly question problem formulations seems the obvious key. Teachers know that it takes time to develop these skills. Currently in Denmark, however, governmental initiatives push for increased productivity in the educational sector, the consequence being that teachers and students are forced to meet pre-set goals rather than to open up explorative and curiosity driven learning processes. Based on data from their teaching, and referring to De Graaf and Kolmos' (2003) distinction between 'task projects', 'discipline projects' and 'problem projects', Hüttel and Gnaur (2017) showed a drift towards the prioritisation of task and discipline projects over problem projects. Hüttel and Gnaur (2017) attributed this drift to the widespread use of teacher-formulated project catalogues, from which the student project groups prefer to choose their research problem when initiating their problem-oriented studies. In another empirical study, also in an Aalborg University context, Guerra and Holgaard (2016) discussed the lack of clarity of the role of competence for critical thinking in PBL. Within the engineering study programmes, Guerra and Holgaard (2016) proposed translating critical thinking into tangible elements to make critical thinking part of ongoing work incorporating problem identification, analysis and formulation, inquiry, and argumentation for the best solution(s). They translate critical thinking into a questioning model that can be applied throughout students' project work to support their critical thinking: **WHO** (teams of students, facilitators and stakeholders) is **THINKING CRITICALLY** (problem identification, analyisis, formulation and solving) and **OUT LOUD** (group discussions and scientific, motivational, and contextual argumentations) about **WHAT** (oneself, the team, a discipline or other social instiurions) with what **PURPOSE** (solving real life problems, independent learners and relating theory with practise)?

Guerra and Holgaard's (2016) model is meant to be instrumental for engineering students' critical thinking in the context of their project work – 'a scientific enterprise', as Arendt (1971, p. 5) put it in the quote that opens this paper. The situation within the Humanities is however somewhat different. Here "the human condition" is part of any inquiry one way or another, and hence a uniform characterisation of critical thinking is harder to give. We have chosen to emphasise that having 'the human condition' as an inevitable element of any study, requires philosophically and historically reflection. Given its subject of

information systems and digital technologies, the Information Studies programme is a crossover between a scientific constructive enterprise and a philosophically and historically analytical study. In the first year of designing and teaching 'Professional Inquiry', we chose the brothers Dreyfus' book 'Mind Over Machine' (Dreyfus & Dreyfus, 1986) as our point of departure, precisely because it deals with human thinking, information systems and digital technologies on philosophical and historical grounds.

When we accepted the invitation to develop and teach the course "Professional Inquiry", we knew that we were taking on a challenging task. A review of experiences from 30 years of deploying the PBL pedagogy at Maastricht University (Moust, Van Berkel, & Schmidt, 2005) showed already more than a decade ago that, over the years, key elements of the PBL study activities have changed in ways that undermine the original PBL pedagogical paradigm. For example, students' time spent on self-study, preparation for supervision and literature search have dropped, while in the same period, numbers of students per group have increased and students have been employed as supervisors; however, there is a growing fear among staff that the subject-matter is not sufficiently covered. Without conducting a similar investigation at Aalborg University, but drawing on many years of experience teaching PBL at Aalborg University (5 and 33 years), we have noticed that students' investment in PBL study time has decreased, while our attempts to teach-to-task to protect the level of academic knowledge have increased. Similarly, the material and immaterial facilities constituting the PBL learning environment have decreased, while the governmental push on students to shorten their study time has increased. Hence we in the outset acknowledged the cross-press of shortening resources and increased pressure to complete studies on time, but we were optimistic that our effort with the Professional Inquiry course would improve students' critical thinking within the PBL pedagogical paradigm.

Our self-reflection about the course experience is grounded on the work of Schon (1983) about the reflective practitioner, specifically on reflection on action (reflecting on past events and how practice can be developed to build professional knowledge and expertise). Reflection occurs on a cycle of action, reflection, and action. The last four years we have done this cycle of reflection: reflection in action during each course and reflection on action after each course. However, in this paper, we have gone through a longer process of reflection on action. This reflection on action is based on an analysis of a corpus of our lecture notes and the Moodle[1] material consisting in study regulation text, the course descriptions year by year, course activities year by year, student journals year by year, and notes on evaluation. We looked at the students' learning situation: the time slots for studying and the number of activities, and their social situation as newcomers to a foreign country or as Danes having to collaborate with newcomers, as well as the overall educational climate in Denmark: what is rewarded and what is ignored. We related our

aim of teaching critical thinking as part of PBL in a humanistic academic context to this corpus and performed a critical walk through.

We chose this way of looking at our material and experiences because we are doing reflection on our own practice with the aim of improving as teachers. Hence, we do not focus on the students learning, we focus on our reflection on action as teachers in order become better at designing learning environments where the students find themselves motivated and able to learn the competences of critical thinking.

In the next section, we describe the 'Professional Inquiry' course followed by an outline of our didactic considerations. Then, we review our lessons learnt from the four years of teaching the Professional Inquiry course in light of the issue of critical thinking and PBL. Based on which we discuss critical thinking and PBL. We end the paper with a conclusion regarding the question of whether the institutionalised Problem Based Learning (PBL) paradigm allows students to cultivate their critical thinking skills.

FOUR YEARS OF TEACHING THE 'PROFESSIONAL INQUIRY' COURSE

The Information Studies programme offered within the Humanities at Aalborg University is taught in English and admits students holding a bachelor's degree in communication or informatics from all over the world. Many of these master students have difficulty understanding PBL as an institutional frame for their study work, let alone as a motivator for studying. We know this, not only from years of teaching the 'Information Studies' programme, but also from empirical research within the engineering study programmes at Aalborg University, which has revealed that students have difficulty deploying theory in a self-directed learning environment based on real-life problems (Guerra & Holgaard, 2016). Students tell us that in their prior studies, they were told what knowledge to acquire to solve a given problem. Those coming with a bachelor's degree in informatics from a computer science department also have trouble understanding the Humanities' academic culture, because they are used to *solve* problems rather than go back and forth trying to define a research problem. Hence, it is quite a challenge for us as teachers to make the subjects we are teaching relevant and motivating for students, while also making the PBL study form relevant and motivating, and helping students account in scholarly ways for the theoretical knowledge of the curriculum. These difficulties motivated the development of a course specifically aimed to develop students' ability to formulate research questions and scientific problems within the field of informatics. The study regulation describes the 'Professional Inquiry' course as follows:

*'**The module** comprises the development and phrasing of empirical inquiry for enabling students to formulate research questions and examine scientific problems within the field*

of informatics. This development will form the basis of the problem-based project work and inquiries to be carried out during the informatics study programme. Objectives: In this module, students will acquire (1) ***knowledge of*** *the connections and differences between empirical inquiry and research questions based on informatics, the connection between research questions and the theory of science in the organisation of scientific research, and theory of science within the field of informatics; (2)* ***skills in*** *describing empirical inquiry, translating empirical inquiry into a scientific research question within the field of informatics, and combining a scientific research question with the theoretical basis of its investigation; and (3)* ***competences in*** *preparing scientific research based on personal enquiry, taking a reflective approach to the basis of scientific inquiry, and engaging in disciplinary collaboration on scientific problem formulation'. (Own emphasis).*

In 2014, we developed and taught the first edition of the course, which was well received by the students. We received positive student evaluations, and some students even approached us asking for a continuation of the course in the following semesters because they found that a continuing focus on the course topics was valuable to the development of their study practice, specifically in relation to 'academic writing', 'listening' and 'giving feedback'. However, the students made no mention of more abstract elements such as 'critical thinking', 'problem formulation', 'PBL' or 'professional inquiry'. The course evaluation is a pass or fail of a seven-day take-home assignment on a set topic, or students have to perform a specified set of activities to a satisfactory level and show active participation. Almost all students choose the second option.

Table 1 presents an overview of the design of the 'Professional Inquiry' course from 2014 to 2017. The overview shows that, over the years, our focus slid from espoused theory to professional identity development because we gradually became increasingly concerned with 'finding the students where they really are' (Kierkegaard[1]). Overall, the lectures were shortened and the learning-by-doing parts were given more time.

[1] The Danish philosopher Søren Kierkegaard is famous for the following dictum regarding what he calls 'the learning profession': *'This is the secret in the entire art of helping. Anyone who cannot do this is himself under a delusion if he thinks he is able to help someone else. In order truly to help someone else, I must understand more than he, but certainly first and foremost understand what he understands. If I do not do that, then my greater understanding does not help him at all. If I nevertheless want to assert my greater understanding, then it is because I am vain or proud, then basically instead of benefitting him, I really want to be admired by him. But all true helping begins with a humbling.'* (Kierkegaard, 2009, p. 45)

	2014	**2015**	**2016**	**2017**
Course announcement to the Information Studies students in AAU LMS Moodle ®	*'The goal of this "Professional Inquiry" course is for the students to become articulate and skilled in what PBL entails, how to study the PBL way and how to assess the quality of outcomes of PBL studies, all by being exposed to a PBL practice – a practice which encompasses a circle of steps from (a) identifying a self-chosen societally relevant problem – which in this case means competence in professional inquiry in and outside of Academia, (b) engaging in searching for literature and empirical facts, (c) problem delineation, (d) empirical and theoretical inquiry, (e) experiments, (f) production and (g) writing up a shared project report.'*	*'This Professional Inquiry course will teach students how to become professional inquirers. Two points are worth emphasising: professional inquiry is a craft, learned through practicing, and it is very much a collective, collaborative act of going back and forth over arguments in acts of listening and questioning. You do not become a professional inquirer by following this course, but you can learn how to become one. In each session we deal with one of the constituents of professional inquiry, the knowledge we present is "accumulative", the themes are linked, and you cannot skip participating actively.'*	The same announcement as in 2015	*'The module presents PBL as a pedagogical model and as a backbone of research practice. Students learn through hands-on exercises and critical reflection of how to make a problem formulate their driver of inquiry. The course highlights how to treat a "problem" theoretically, through empirical investigation, all within the field of Information Studies. The module will use a framework we call "Professional Inquirer in the PBL way" as a map of the landscape of knowledge and skills to be acquired through the course.'*

Teachers' focus and topics	**Focus:** PBL and how to become an academic scholar **Topics**: PBL, scale of professional competence development, search for literature, problem formulation, research methodologies and methods, writing	**Focus**: PBL and the ability to understand and discuss academic literature **Topics**: PBL, the concepts of epistemology and ontology, research methods, tools and methods for Professional Inquiry, problem formulation, fact checking	**Focus**: PBL and capability of critical thinking when performing as a professional inquirer **Topics**: PBL, identity of a professional inquirer, methods and tools for professional inquirers, fact checking, scholarly ways of reading and writing	**Focus**: PBL and how you organise theories, data and techniques around the problem **Topics:** PBL and the professional inquirer, scholarly ways of reading and writing, tools for problem identification, the process of problem formulation, fact checking
Teaching activities	Lectures. Asking questions the Action Learning way. Writing exercises and submissions to an online blog. Self-assessment of PBL competence using the Dreyfus & Dreyfus competence ladder. Training in identifying the research problem in academic articles. Problem formulation using Creswell's scheme. Reformulating the problem using the ten steps framework. Designing an experiment. Skilled performance through role play training, case: job interviewing.	Lectures. Reflective Journal: Between 1 and 2 pages per week about the theme of the week, with written teacher-feedback. Training in chairing a Professional Inquiry discussion of a teacher-chosen paper. Writing a paper: Each student is required to write a five-page academic article demonstrating skills as a professional inquirer, with written teacher feedback. Skilled performance through role play training, case: job interviewing.	The same as in 2015 with some literature changes	The same as in 2016, except that skilled performance was replaced by a LEGO® SERIOUS PLAY® workshop on problem formulation

Table 1: Course Design 2014–2017

DIDACTICS OF THE 'PROFESSIONAL INQUIRY' COURSE

As stated in the introduction, we consider cultivating critical thinking and critical reflection and developing the ability to repeatedly question problem formulations essential for developing students' ability to determine what is worthwhile knowing. In our teaching, we drew on three theoretical sources to help the students build their understanding of critical thinking. Schön's (1983) 'The Reflective Practitioner' outlines the concepts of reflection-in-action and reflection-upon-action with examples. Schön (1983) introduced the concept of 'repertoire', suggesting that students should have their own 'tool box' and noting that 'a practitioner's repertoire includes the whole of his experience insofar as it is accessible to him for understanding and action' (p. 138). This repertoire influences the capacity for critical thinking because it includes the experience itself, understood also as knowledge, the ability to determine the elements that are hindering the achievement of the expected outcome and the resources available to be used. How the person sees the situation and their capability to explore it depends on their repertoire.

We drew on the Action Learning approach (Revans, 1980) to help students conceptualise the process of integrating theoretical and situational capabilities by cultivating the skills of listening and asking questions. Revans (1980) emphasised how it feels to find oneself in a condition of ignorance, risk and confusion, and explained how to frame and ask uncomfortable questions and to listen and hear the answer – skills that also apply when reading the work of scholars.

In 2016, we introduced Hamby's (2013) account of the virtues of the critical thinker – charity, openmindedness to evaluate arguments, valuing fallacious-free reasoning and willingness to inquire – to improve the students' grip on critical thinking in academic and professional practices. Hamby (2013) described critical thinking as the ability to identify an argument, analyse and evaluate arguments, clarify terms and statements, evaluate authors and sources, make inferences, formulate conclusions and examine alternatives. Overall, we staged our teaching to make the students aware of the following activities to familiarise them with critical thinking:

Reading for learning: After an initial teacher-led paper discussion, where we tried to show the students what we were aiming to achieve, students worked individually or in pairs to pick from the mandatory readings and formulate a set of questions. All students had to read the literature and answer the questions; emphasis was placed on making the

discussion a professional inquiry experience. We also led a discussion to provoke the students to make reasoned arguments about their positions.

Professional inquiry performance: Over the first three years of the final course session, we attempted to encourage students to articulate their conceptualisation of the professional inquiry competences. We handed them a 'UX designer' job ad and asked them to prepare for a job interview. The questions during the interview revolved around the competence of a professional inquirer in ways relevant to the job position. We took turns playing the role of job-interviewer on a stage in the corner of the classroom, while the class followed and actively commented on the performances.

Reflective journal: To support students' personal engagement with the content of the course, they were invited to express their knowledge through a personal process of self-exploration and self-questioning. The journal comprised five entries, in which the author discussed and reflected, in writing, upon such things as their experiences, ideas, assumptions, theories, progress and positions of scholars. We called this journal, 'Becoming a Professional Inquirer'. The idea was that, at the end of the course, the journal would form the base for writing the final academic assignment.

Short paper: The last assignment was an academic paper, which combined the different pieces of knowledge from the course. For example, in 2015, based on a paper from the reading list (Chenail, 2011) which they said they found informative, put into perspective by their experiences during the course, the students were instructed to write a five page article developing the topic of 'The Ten Steps of Professional Inquiry'.

LEGO® SERIOUS PLAY® workshop: This workshop was introduced in 2017 to encourage students to externalise their understanding of professional inquiry using their hands, materials and storytelling to mediate the conceptualisation of what Professional Inquiry means. Working in two groups, the students' work was video-recorded, and they were required to watch and analyse the video tapes.

Reviewing problem formulation: Following a list of effective problem formulations and based on the paper "Ten Steps for Conceptualizing and Conducting Qualitative Research Studies in a Pragmatically Curious Manner" (Chenail, 2011), the students were asked to evaluate problem formulations written by former students.

PBL navigation map: In 2017, to improve students' overview of the PBL project work, we devised a checklist to remind students of the flow of the project work and the role of problem formulation.

LESSONS LEARNED FROM TEACHING THE 'PROFESSIONAL INQUIRY' COURSE

Despite the positive student feedback in 2014 (the first year of the course) we found that at least two aspects of the student performance deserved more attention in our teaching: students' general performance in academic writing and students' courage to face conflicting positions in oral academic discussion, for example, during the action learning sessions. Additionally, we did not find any spill over from the students' work on problem formulation in the Professional Inquiry course to the problem formulations they presented in their project work. Figure 1 shows an example presented by a group of three students.

Current problem area:

We would like to understand how and with what purpose Danish high school students use laptops in the classroom (and outside school for learning). Furthermore we would like to explore how this user practice adds to or interfere with learning in the classroom.

To answer this problem we would like to observe (preferably for a week) how high school students use their computers in class and how it affects the classroom and their learning. We want to explore what the role of the computer is, whether or not the computer is integrated in the classroom or it functions like a barrier between teacher and students. We also want to know what the intended use of the computers are and if those intended uses are the actual uses of the students. To gain knowledge about this we would besides the observation study also like to interview some of the students and one or more teachers.

We want to conduct our observation study without participation in class because we don't want to affect the dynamic between teacher and students. Also we cannot see what they're doing/notice it, if we participate in class. We have a cooperation with [redacted] Gymnasium and a teacher that has volunteered.

Figure 1: Problem formulation presented in 2014

This problem formulation is put into perspective by the self-evaluation of students' PBL skills presented in Table 2; students marked with an asterisk (*) wrote the problem formulation reproduced in Figure 1 (two Danes, one AAU bachelor in communication, one IT bachelor from a university college, and a French IT bachelor). This group considered themselves competent and proficient in PBL skills.

PBL Skill	**Level of competence**				
	Novice	Advanced Beginner	Competent	Proficient	Expert
Identify a self-chosen societally relevant problem	Z	G*	A*, D, P	L*	
Engage in search for literature and empirical facts		A*, G*, Z	L*	P	D
Engage in search for empirical facts	G*	Z,P	A*, L*	D	
Problem delineation		G*, D, Z	L*, P	A*	
Empirical and theoretical inquiry	Z	D	A*, G*	L*, P	
Experiments	Z	D	A, G	L, P	
Production	A*		L*, D, Z, P	G*	
Write up in a group of collaborating students a project report answering and critically discussing the problem initially formulated		Z	G*, L*, D	A*, P	

Table 2. Example of a Group's Self-evaluation of Their PBL Skills

We suspected that the lack of visible spill over was due to the course format, and we considered that we had not been sufficiently clear that the course was for their future academic and professional life. Looking in the rear-view mirror, we might have profited from using our observation of the lack of spill over in our 2015 course introduction as a critical reflection exercise in the beginning og next year's course work. Instead, we attempted to address more directly the academic and professional life perspective by emphasising the basics of communication by performing exercises involving asking questions and listening to answers. Regarding the reading for learning activity, we saw that students this year showed more control over the discussion and presented critical and reflective questions about the text and about fellow students' inputs. We detailed our feedback on the reflective journal entries and received positive feedback from the students as shown in the following example: *'I just want to say thank you for giving me feedback in this way. It is nice to try it, and actually, for me, it is easier to understand and it seems more manageable to approach the feedback and rewrite, e.g. the paper. It is nice to get feedback like this'*. Nevertheless, we were still not happy with the outcome. Students continued to narrate in their written entries rather than develop skills in academic critical writing. We discussed the clash between on the one hand finding students where they are and giving them a voice, and on the other, making students meet scholarly criteria for dealing with academic literature and expressing their personal experiences of deploying the taught espoused theory.

When we reviewed the students' final papers, we found that few included an introduction, research questions, methodology, use of theory, a conclusion, references and convincing argumentation. Nevertheless, the students' evaluations expressed satisfaction with the Professional Inquiry course, and for us, it was immediate gratification to follow the developments in the students' writing and see definite improvements, although few presented a satisfactory level of academic performance.

In 2016, we retained the 2015 design, modifying only the literature and focusing more on the aspect of critical thinking from the perspective of Schön (1983) and Hamby (2013). The outcome of the 'reading for learning' activity was weaker in 2016 than in 2015, and the journal was still the most relevant activity, seen from a training viewpoint for both critical reflection and problem formulation. The final paper quality and the positive feedback we received were the same as those in 2015.

In 2017, we introduced a LEGO® SERIOUS PLAY® workshop to help the students develop a deeper understanding of the problem formulation process by connecting hands and mind. The workshop fostered a rich activity of interaction and in-depth discussions. However, the quality of the journal entries were on a par with those of previous years: The students focused on following the instructions for the task of each entry, but they mentioned that this workshop was one of the most significant activities of the course. Regarding course spill over to project work, we saw the same problem as in previous years (figure 2). The students failed to reflect critically upon the problem formulation or exhibit critical thinking characteristics such as references to related work, reasoned arguments, and distinctions between analysis and judgement of outcomes of analysis.

– What is the RQ?

How using Tinder connect and disconnect human relationships within the dating practice in Denmark?

- What is the difference between traditional dating and "Tinder dating" in Denmark?
- How do Tinder users feel about using Tinder as a dating tool? What motivates/demotivates them? Expectations regarding their dating practice?
- How does Tinder's #swiperight and other features of the app connects people and disconnects them at the same time?

Keywords: connecting, disconnecting, online dating, user-practice, social interaction

– What is the unit of analysis?

People living in Denmark. Danish people in the dating scene + foreigners who are open to adopt the "danish way of dating". (Individuals)

– What type of case study?

Type 1, based on Yin

– How are data collected and analysed?

- Qualitative research through thematic analysis - desk research + interviews + focus group + Nvivo for data analysis.
- Practice as activity
- Principle of hermeneutics/multiple interpretations,...?

Problem formulation group 1	Problem formulation group 2

Figure 2: Examples of problem formulations 2018

Our conclusion is that although students have always been willingly, almost enthusiastically, engaged in the course activities, the Professional Inquiry course has, over its four years, failed to instil critical thinking methods into the students' problem formulation practices.

CRITICAL THINKING AND PBL

We consider PBL, in the form of an institutionalised pedagogical paradigm, a learning structure for cultivating students' skills to integrate espoused theory and practical problem-solving in a scholarly fashion. Structures can support or prevent learning, or be ignored by the learner; if in line with the learner's activity goal, they provide support. It thus makes a difference whether the student's goal is to study to complete a task or to find out what is worthwhile knowing. Our teaching experience indicates that PBL is a learning structure that supports forward going, constructive and solution-oriented learning, and it thereby fits a learning goal of writing a project which meets the criteria of the study regulation. Critical thinking is, however, a process, which, when students engage with it, moves students' thinking in a backward-looking, problematising direction, asking about context and contribution. Ideally, the constructive and reflective movements of thought are complementary, as pointed out by all experiential learning theorists (Miettinen, 2000). However, as mentioned in the introduction, within PBL as the institutionalised

pedagogical paradigm, as is the case at Aalborg University, one project per semester leaves little room for reflecting upon action, let alone engaging in a process of critical reflection. As we see it, time pressure forces students to cut back on or ignore critical thinking and put their full effort into providing at least one – what they consider – good solution to their chosen problem. Dissolving the potential conflict will require a dispensation from the pressure for efficiency currently framing all university teaching and learning. Is this a too far-fetched conclusion? Perhaps the following student blog entry hints as to why the tools for critical thinking learned during the Professional Inquiry course were not used much: *'Considering all 10 steps is extremely time-consuming, and formulating my thoughts on some of the steps has been very hard. I do recognise the value of planning a study and am aware that it may save time later in the study. It may also help to keep the answering of the problem statement on track*'. When under time pressure, students rely on old habits of learning to task, rather than learning to inquire.

In the wider societal perspective on education, where, for example, the UNESCO announces critical thinking to be a 21st century skill for all citizens, and where critical thinking is considered the backbone of scholarly competence, there is a tendency to ignore the actual practical conditions for exercising critical thinking. We attribute this lack of practice focus to diverging understandings of how critical thinking is built through action as a skill in an experiential learning view. This view also applies to discussions of the relationship between critical thinking and PBL, where critical thinking is considered one of the core competences to develop.

In pedagogical research on PBL (Kamin, O'Sullivan, Younger, & Deterding, 2001; Kumar & Refaei, 2017; Masek & Yamin, 2011; Sada, Mohd, Adnan, & Yusri, 2016; Sendag & Ferhan, 2009; Ward & Lee, 2002; Yih Chyn & Huijser, 2011; Zabit, 2010), we find two different positions regarding how this relationship is to be understood: Some scholars see PBL as instrumental to their aim of teaching critical thinking (Kumar & Refaei, 2017), while others state that critical thinking skills develop through the students' way of working with inquiries into their chosen problem (Yih Chyn & Huijser, 2011). Kumar and Refaei (2017) conducted an exploratory study of the role of PBL pedagogy in promoting students' critical thinking, designed problems to support students' development of critical thinking in their writing and explored how the problems served to prompt students to apply critical thinking skills to their writing. The findings showed that PBL pedagogy supported the students' critical thinking, which became evident in the students' writing. Yih Chyn and Huijser (2011) considered PBL pedagogy as a way of studying, where students simultaneously acquire domain-specific content and learn critical thinking skills.

However, from our experience, students will not develop critical thinking skills by experiencing the process of PBL alone. We find that students do apply a certain level of

critical thinking in their project activities but without consciously dealing with scholarly critical thinking, which implies that they do not consciously put critical thinking in their toolbox as academics or make it part of their repertoire. Guerra and Holgaar (2016) identified this implication in their research, stating: *'Undoubtedly, problem analysis and formulation enhance students' critical and reflective thinking, but students might need to address these challenges step-by-step with clear learning objectives—and then develop their PBL skills to manage a comprehensive PBL process. However, there is also the risk that the PBL process in itself is not questioned. In the interviews, students recognised that during their three years of study in this particular PBL environment, they had developed a kind of mechanical way of formulating and solving problems' (Guerra & Holgaard, 2016, p. 434).*

A literature review developed by Masek and Yumin (2011) concluded that (a) the specific process in PBL pedagogy theoretically supports students' critical thinking, (b) the empirical evidence is inconclusive in explaining the effect of PBL on students' critical thinking ability, and (c) some evidence shows that PBL pedagogy requires long-term exposure to foster students' critical thinking ability.

Our teaching experiences support these findings, and we hope that the institutional frame around PBL will become adjusted to support the development of critical thinking progressively from one semester to the next. We consider that such adjustment will increase attention paid to conditions for the unfolding critical reflection on the course's project work for the students and for the teachers, and place greater emphasis on critical reflection in the system of grading and passing exams.

CONCLUSIONS

We have here described dilemmas involved in developing students' critical thinking within the pedagogical paradigm of PBL based on a case within an institutionalised PBL practice. We have addressed the conditions under which it might be possible to allow ourselves, as teachers, to experience surprise, puzzlement, or confusion *with the students*, and to reflect upon prior understandings.

Our work with designing and teaching the 'Professional Inquiry' course to graduate students has led us to reflect more deeply on how to help students acquire critical thinking skills. We have identified an apparent conflict between PBL and critical thinking in practice, which can be divided into the following four sub-conflicts:

- a conflict between project work to solve a real-world problem and critical thinking, which requires a process of reflection upon existing knowledge and a reformulation of the problem, perhaps several times;
- a conflict between teaching critical thinking in isolation in a single course and making critical thinking part of all scholarly thinking (as it should be);
- a conflict between the limited time students devote to their study work and the time they need to think critically; and
- a conflict between seeking to meet the study regulation demands within the hours allocated to us as teachers and meeting the students where they are.

To a large degree, these conflicts are shared by most university courses and are amplified by the governmental demands for student efficiency, including several incentives to make students graduate 'on time'. Rushing education, in Denmark and elsewhere, is detrimental to the cultivation of students critical thinking skills.

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Laptop Riser, a Useful PBL Project for Diploma Students in Engineering Design

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ABSTRACT

A useful project is identified for the semester-four diploma students in their final workshop of mechanical engineering program in the school of engineering at Australian college of Kuwait (ACK). ACK is putting significant emphasis in project based learning (PBL) and is developing new courses for both diploma and degree programs according to PBL style. In the final workshop project, it is required that the students design and manufacture a foldable laptop riser during fourteen weeks of their works. This project uses welding, cutting, drilling, and bending processes. It is expected that the deliverable product of this workshop is to be used in offices of ACK faculties and staff to raise the laptop height to provide an ergonomic and healthy office use. Students gain experiences in developing their own ideas, acquainted with preliminary design calculations, make sketches and drawings, build their laptop risers, and report their learning outcomes. The students are allowed to work individually or in a team of two to three students. The students are asked to satisfy specific requirements and fulfill certain restrictions such as pre known available materials, sizes and dimensions, and quality of finished product. We found that students are satisfied with their learning and developed skills and also enjoyed to see their end products are utilized in the ACK offices.

Keywords: Design process, Laptop riser, Project based learning, Workshop project.

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INTRODUCTION

The concept of problem based learning (PBL) was probably initiated from McMaster University (De Graaff & Kolmos, 2007) although the idea was applied in nursery schools, medical sectors, and other areas earlier (Schweinhart & Weikart, 1997; Van der Vleuten et al., 1991; Sang, 2001; Schmidt, 1993). The acronym PBL was later extended to Project Based Learning in engineering discipline (De Graaff & Bouhuijs, 1993; De Graaff et al., 2006). A PBL facilitator guide was developed in Australian College of Kuwait (ACK) for consistency of delivering all PBL units in ACK in which the instructor job is described as "facilitator" rather than general lecturing (Jaeger & Adair, 2015; Jaeger, 2017). The effective learning of students in PBL are described by project oriented, student self-directed, activity-based, real life context, analytical thinking required, and team-based learning. In the PBL environment, students should work professionally to develop a useful end product satisfying customers, here stakeholders from the ACK staff and the workshop instructors and teaching and workshop assistances. During workshop sessions, students should follow all safety rules and should wear personal protection equipment (PPE) at all times. In the ACK PBL environment, the emphasis is on learning outcomes (Jaeger, 2017); therefore, students may pass their workshop if they perform their tasks professionally. It is important for the workshop unit that the end product is deliverable and meets requirements; although, more credential will be given to quality executed projects.

THE MECHANICAL PROJECT SEMESTER 4

The unit of "Mechanical Project Semester 4" delivered in the department of Mechanical Engineering at ACK, introduces occupational health and safety regulations regarding workplace, machines and hand tools; layout and mark dimensions on work piece; perform basic bench work operations: machining, such as drilling, tapping, forming, shaping, filing, welding, and cutting with hacksaw, assembling of components, and checking all components for conformance to specifications. The course objectives and student learning outcomes of this unit are listed as:

1. Independent and self-managed performance,
2. Work effectively with team - all team members are expected to contribute accordingly,
3. Apply knowledge on safety procedures and use personal protective devices,
4. Select materials according to the requirements specified in the drawing and provided materials,
5. Layout and mark dimensions and features in accordance with drawing specifications using bench work tools and equipment, and
6. Check the components for conformance to specification.

THE PROJECT OF LAPTOP RISER

The brief explanation of the project as was expressed for all workshop students in semester 4 in the department of mechanical engineering at the Australian College of Kuwait in fall 2016 is as follows:

Project Requirements

ACK requests the design and manufacturing of foldable laptop riser that will be used in offices to raise the laptop while working to provide an ergonomics healthy workplace (Ergonomic Benefits of a Laptop Stand, 2017). The design process will involve preliminary design calculations, sketches and drawings. As for manufacturing, your capacity must include:

(i) Welding,

(ii) Cutting,

(iii) Drilling, and

(iv) Bending.

The purpose of the final piece of design will be used later in ACK for other extra-curricular indoor/outdoor activities and for marketing purposes. The students will be divided in teams.

Design Restrictions

The task is to deliver a high quality laptop riser. The product should be stable, looks nice and rigid structure. The requirements are set by the instructor and he would like a student to be designer and manufacturer of the product. To complete this task, students must meet the following design minimum requirement:

1. Adjustable height to the maximum of 27 cm,
2. The size of the riser should not occupy more than 45x45 cm space on the table,
3. Inclination adjustment,
4. Laptop size (12-17 in),
5. Screen flexing backwards,
6. The space under the tray can be used to store external keyboard,
7. Laptop ventilation to take laptop heat away,
8. Safety features for example no sharp edges or harmful to touch,
9. Easy to handle or adjust,

10. Light in weight,
11. Aesthetics: looks good,
12. Balanced: doesn't fall when laptop is mounted, and
13. Must have good cables management.

Design Factors & Criteria

In addition to the minimum requirements, certain design factors that students must consider to score highest marks are:

1. Safety,
2. Reliability,
3. Durability,
4. Recyclability,
5. Ease of storage, and
6. Ease of operation.

Available materials

1. The team is requested to design and build the structure based on the given constraints and criteria.
2. Each team will be provided with a set of raw material that must be used for the project.
3. The team will provide the instructor with final and confirmed design with CAD drawings showing all details (assembly and each part) about the design including all dimensions. Students are not expected to provide drawings on hardware such as screws, bolts and nuts unless designed especially for this project.
4. Any late submission (report or prototype) will cause a 5 mark deduction per day late (maximum 3 days after which no reports will be accepted!).
5. Sufficient materials will be provided. No additional materials will be provided.
6. It is unacceptable to change the design after submitting the final design.
7. Tasks should be divided among team members as each student will be evaluated based on his contribution instructor observations through the semester.

Report documentation & presentation

Final Report must be submitted on week 14. The report should include all details about the design. Additional details may include:

1. Mathematical calculations,
2. Component and assemble drawings,
3. Bill of materials,
4. Assembly instructions,
5. Tools information, and
6. Cost information.

Grading of Products

The instructor will give the highest mark to the best project based on the following criteria

1. Meeting the instructor requirements as stated above,
2. Stability of structure,
3. Precise connections of structural,
4. Quality of the finished product. (Welding, drilling, cutting & bending),
5. Resources used,
6. Sustainability impacts, and
7. Strength.

METHODOLOGY

The students start with developing their own ideas and complete their designs by week four. All drawings must be generated using a standard CAD and be completed by week 4. The system drawing details should be clear enough for manufacturing. Team should also provide extra information such as:

- Any extra materials, additional screws in case they are unavailable at the workshop.
- Cost comparison between the riser built by the team and risers already available in the market.

Students must show high level in the following skills in building the riser during weeks 5 to 14. They will be assessed on cutting, welding, drilling and bending. All the four skills must be used in these workshop sessions. No external work source or work outside of the workshop is accepted. Safety in attending the workshop is the highest priority. Any student does not follow the safety rules will automatically excluded from workshop. PPE must be worn at all times. Any student missing three workshops will fail the unit. Students should adhere with the ACK

workshop behavior policies. Students without PPE were not allowed to participate with the workshop activities. All products must be submitted by week 14 or earlier if completed.

RESULTS AND DISCUSSION

Team Design 1

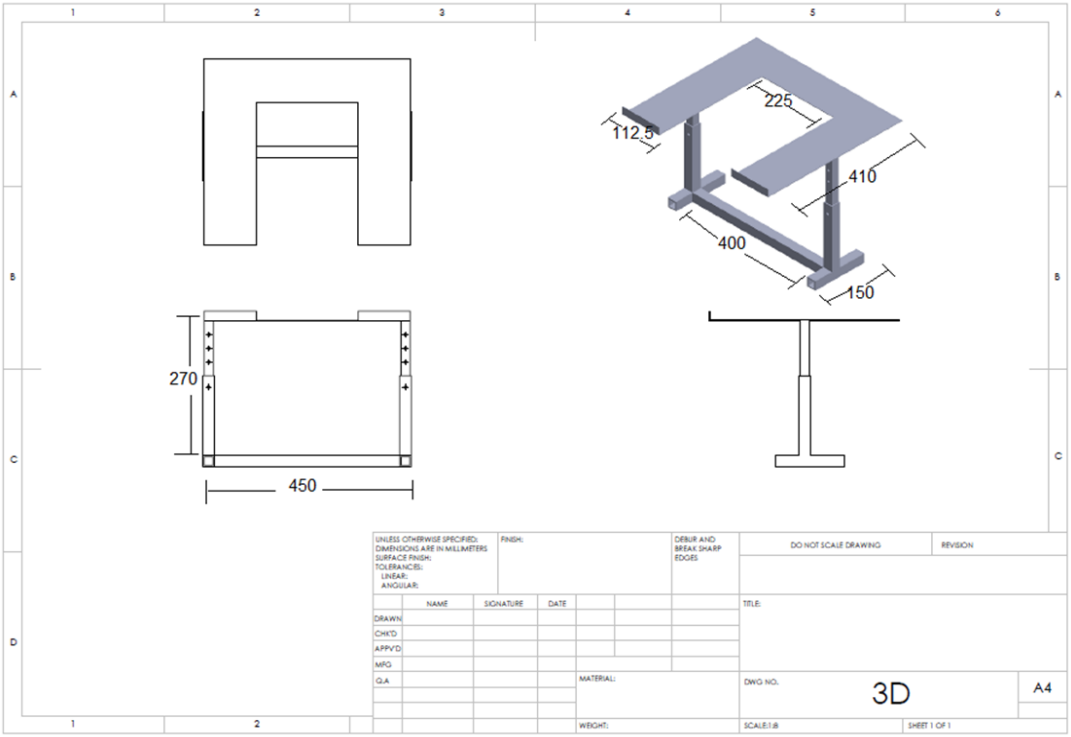

Figure 1: Team 1 design of a laptop riser

Team 1 had designed the laptop riser as shown in Figure 1. The inclination was provided with a locking knob and hinges are used to adjust the height of laptop riser to desirable height. The overall weight of the manufactured riser was 3.2 kg and all requested processes were applied (see Figure 2). The finishing of the product was impressive and the end product is adopted in one of ACK offices.

Figure 2: Team 1 the manufactured laptop riser

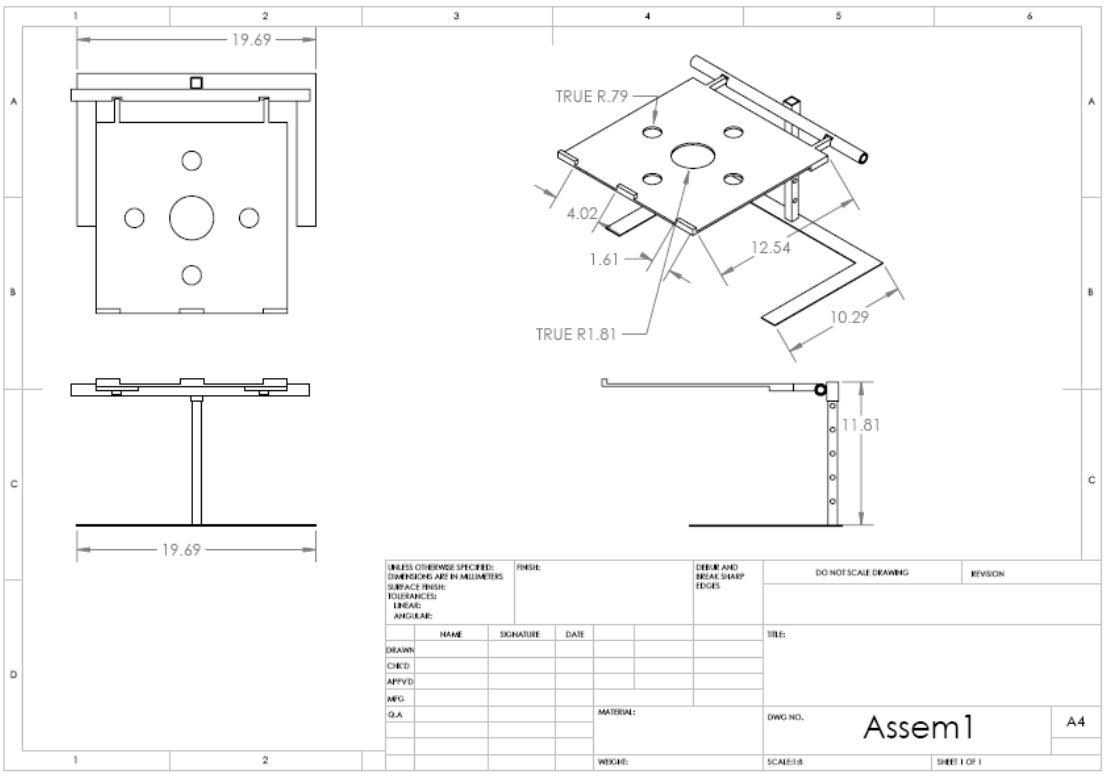

Figure 3: Team 2 the design of a laptop riser

Team 2 designed the laptop riser as shown in Figure 3. The inclination was provided with a new idea of using double tubes and hinges to adjust to desirable angles. The height of the laptop riser was adjustable using square tubes. The overall weight of the manufactured riser was below 3.5 kg and all requested processes were applied. The finishing of the product was satisfactory and the end product is used in an ACK office.

CONCLUSIONS AND RECOMMENDATIONS

ACK has a rigorous plan to promote PBL courses in the Engineering departments, including Mechanical Engineering, to foster sustainable engineering development. The unit of "Mechanical Project Semester 4" has progressively been improved over the past few years. This workshop unit is now developed to expose our final year diploma students with real life problems and challenges. This would allow students to familiarize themselves with the PBL style of learning.

Most of the successful students in the diploma program are now pursuing degree studies. At ACK school of engineering presents some of the students' achievement in PBL units in the exhibition day. Since PBL scheme is introduced to both diploma and degree programs we recommend arranging a PBL exhibition day alongside the ACK PBL symposium day or side by side to the school of engineering graduation exhibition day. By sharing the details of course and reporting experiences we aim to provide some insight for implementation of the course in other institutions.

The restrictions are imposed to student are the required processes of welding, cutting, drilling, and bending and also to use ACK workshop materials and tools. During the first four weeks students develop their design ideas and finalize their Auto-CAD drawings and for the rest of weeks they build their laptop risers. Students have to follow supervision of instructors, workshop tutors, and workshop technicians. Based on the experience of this course we would add an estimate of the needed budget for the future semesters detailed about materials and processing cost and required man power which will be used for assessment of the product.

Students are encouraged to send and receive feedbacks which have helped considerably on how to run this workshop unit and how to help students to achieve their best. From the received feedback, more examples of previous semester project ideas shared with students, and the developed knowledge are shared among lab technicians, instructors, and new students. Examples of what entries are expected in their final reports are explained. These changes, together with the eagerness of ACK students to learn and to have hands on works, created a promising learning environment.

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Clinic for Rehabilitation and Disability Psychology: A PBL-based Master Degree Programme for Psychologists

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ABSTRACT

Problem-based learning (PBL) is widely recognized as a pedagogical approach across disciplines. However, the relevance and application of PBL in psychology has received limited attention. Therefore, this article presents a PBL-based master degree programme for psychologists. The article is divided into three sections. First, we present the rationale and need for developing this programme. Second, the programme curriculum is described in detail and, third, the programme's practical and theoretical aspects and potentials are discussed in light of PBL principles.

BACKGROUND

The field of Rehabilitation Psychology advances the psychology of disability, chronic illness, and whole person functioning, in the context of the environment and community. The idea of rehabilitation psychology is to improve the lives of individuals with disability and chronic illness across the lifespan and within and across a wide range of settings (e.g., medical, inpatient/outpatient, home). It rests on, but expands from, the more established but narrower biomedical model of rehabilitation. As such, rehabilitation psychology, provides services with the goal of increasing function and quality of life for persons with disability and chronic health conditions that limit activity and restrict social participation. In the US, rehabilitation

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psychology has been an established field within psychology for more than 50 years. The American Psychological Association defines Rehabilitation Psychology as:

> "A specialty area within psychology that focuses on the study and application of psychological knowledge and skills on behalf of individuals with disabilities and chronic health conditions in order to maximize health and welfare, independence and choice, functional abilities, and social role participation across the lifespan."
>
> (http://www.apadivisions.org/division- 22/about/rehabilitation-psychology/).

While some European countries (e.g., Germany, Norway, Sweden and the UK) have integrated this field in psychology, it is yet to be developed in Denmark. Despite calls for a paradigmatic change in Danish rehabilitation, from a sole biomedical focus on individuals with problems to a more coherent bio-psycho-social focus, research (Pallesen, 2011; Hald, 2011; Glintborg & Hansen, 2016) reveals that rehabilitation practice is still mainly based on biological and practical aspects. Our study of clients aged 18-66 years with acquired brain injuries (N = 82) and their close relatives (N = 40) revealed major psychological problems (e.g., depression, decreased quality of life and identity problems) in both clients and their close relatives (Glintborg, 2015; Glintborg & Krogh, 2015a; Glintborg & Hansen, 2016). While clients and relatives were found to receive physical training and practical support, major psychological problems remained unaddressed (Glintborg & Hansen, 2016). We assume that this is not the case for brain injury rehabilitation only, but for rehabilitation practice in Denmark in general[1]. Therefore, based on research that documents authentic psychological problems in practice, we developed the master programme Clinic for Handicap and Rehabilitation Psychology (CHaRe) as a first step towards meeting this need and establishing rehabilitation psychology as a field in Denmark.

THE CHaRe PROGRAMME: A PBL-BASED MASTER DEGREE PROGRAMME FOR PSYCHOLOGISTS

In the following section, we describe the Problem Based Learning (PBL) organised master degree programme CHaRe for psychology students at Aalborg University. PBL and curriculum based strategies can be seen as two different learning paradigms. Curriculum based strategies traditionally rely on instructional design that focuses on knowledge transfer and teacher controlled learning processes. In contrast stand PBL strategies that draw on social-constructivist approaches focusing on providing conditions for students' active construction of knowledge, working with real life tasks, and learning in collaboration with others (Jonassen, 1994).

[1] We also suspect that the problem of overlooking psycho-social sequelae after major injury, and the potentials of psychology for assistance in this area, is probably not limited to Denmark

The use of PBL strategies has increased since it was launched more than 30 years ago. Despite several definitions of PBL, some commonalities can be found across definitions. At its core, a problem-based approach is designed to help students achieve two goals: (1) acquiring a deep understanding of specific content knowledge, and (2) developing problem-solving and higher order thinking skills (Ertmer & Macklin, 2006).

At Aalborg University, PBL has been part of the University's pedagogical profile since the founding of the university in 1974 and this particular version is often referred to as The Aalborg PBL model (Kolmos, Fink & Krogh, 2006). The Aalborg PBL model draws on Critical Theory, especially the work of Oskar Negt (1971) who proposes a renewal of existing education programs. Negt's work is inspired by the concepts of experimental learning and self-regulation. A basic characteristic of the model is that the starting point is the problem, not the curriculum. In addition, there is a strong focus on participant control (e.g., the student chooses the subject for the project), interdisciplinary approach (integrates insight from different scientific disciplines), and project organization (a group of students).

CHaRe is offered to students with a BSc in psychology as a master degree programme at the Department of Communication and Psychology at Aalborg University (AAU). CHaRe aims to prepare and qualify students for future work in various settings as rehabilitation psychologists. The programme spans three semesters plus the master's thesis and is organized partly in relation to curriculum, and partly in relation to clinical practice where students will offer a manual based intervention programme to clients with disabilities (e.g., acquired brain injuries, multiple sclerosis, mental illness, etc.) and their close relatives. The programme was launched in autumn 2015 with 10 students and has expanded to admit 14-16 new students each year.

Overall the four semesters seek to accommodate progression from appropriation (1st semester) → application (2nd semester) → reflection and dissemination (3rd semester) → innovation (4th semester) with regard to Danish rehabilitation psychology.

First semester: Appropriation. During the first semester of the programme, the students participate in various 2-4 day workshops in which basic rehabilitation psychological research, definitions, models, foundations and interventions are taught. The use of workshops corresponds to the PBL understanding of learning, where knowledge is actively constructed by the student rather than passively received from a teacher. In addition, seeing learning as a social and situated process emphasises group work, dialog and situated activities (Bygholm & Buus, 2016).

In terms of content, the programme is rooted in the bio-psycho-social understanding of health represented by the International Classification of Functioning (ICF) (WHO, 2001). The bio-

psycho-social model focuses on the dynamic interaction between the client, relatives, professionals and the community environment (Engel, 1977). It emphasizes the importance of paying equal attention to biological/physical, psychological and social aspects in disabilities and of adjusting rehabilitation efforts to changes in the individual's bio-psycho-social needs.

Therefore, rehabilitation psychological interventions address not only clients' psychosocial needs, but also those of their close relatives. Family interventions must be conducted to meet the changing needs of clients *and* relatives. Rehabilitation psychological interventions address needs of clients and core relatives by beginning with a formal assessment of their current situation (Kennedy, 2012). In the CHaRe programme, we assess both relatives' and clients' quality of life, self-compassion, level of depression and anxiety pre and post intervention. Information or referral is usually the first intervention needed; later, counselling interventions or support groups, which are offered to relatives in the CHaRE programme (clients receive individual support). Support programmes are designed to increase emotional well-being and decrease isolation. Psychoeducational intervention is also a part of the programme, which has shown positive effects on relatives' and clients' well-being in previous research (e.g., Rivera, Elliott, Berry, Shewchuk, Oswald & Grant, 2006).

The interventions taught and used in the programme are primarily based on the so-called "third generation" of Cognitive Behavioural Therapy (CBT) (Arendt & Rosenberg, 2012). All approaches of CBT share the assumption that certain cognitions, emotions and physiological states unwittingly sustain dysfunction; therefore, therapeutic interventions that address these are helpful. What distinguishes the three generations of CBT is, in very broad terms, the stance taken to these problematic internal events: first generation interventions focus on overt behaviour and thus work only indirectly with mental states, second generation interventions aim at eliminating or reducing problematic internal states, and third generation interventions aim at changing the client's stance towards internal states into accepting them without letting them run the show. The latter can be seen as learning a meta-cognitive (or meta-emotional) attitude towards one's own inner states that bears some resemblance to what is taught in eastern meditation practices, and thus mindfulness training is a shared tool in third generation CBT therapies. This approach is advocated as expanding therapy's target from reduction of current symptoms to development of a general skill that requires fewer mental resources for coping with adversity and leaves more resources for activities in which the client finds value, positive commitment and options for fulfilment. Despite serious illness and disability, learning these new behavioural therapies emphasizes empowerment and an increase in skills and behavioural repertoires that may be used in many contexts (Hayes, 2004).

Therefore, students participate in workshops in Mindfulness, Compassion Focused Therapy (CFT), Acceptance and Commitment Therapy (ACT) and in addition, there are also workshops in Narrative Identity (Identity reconstruction) and Animal Assisted Interventions (AAI).

Based on these interventions and the associated research literature, we (in collaboration with the CHaRE students) have developed two intervention manuals (named BackUp!), one for clients and one for their close relatives.

During the *second semester*, students offer our manual-based intervention for clients and relatives in three Municipalities; Aalborg, Vest Himmerland and Vejle. We achieved close collaborations with the Municipalities because they recognize the need for rehabilitation psychological interventions and value research-based practice. Therefore, both clients and relatives are recruited from the Municipality and our clinic is situated at two locations; one in the municipality and one at the University. Several other municipalities have expressed interest in the programme and collaboration with these may be added in future years.

Students are teamed up in pairs, which offer individual therapy for clients (12 sessions) and group therapy for relatives (5 sessions). Working in pairs ensures a continuously reflective partnership and constructive critique in between supervisions. Supervision is provided twice-weekly by an authorized psychologist whose experience includes third generation CBT as well as working with ABI clients.

During the third semester, students write a group project. Here, they typically combine practical experience from their internship with theoretical knowledge and thereby further the sophistication of their understanding of rehabilitation psychological perspectives and interventions. Project-organized group work is a hallmark of the Aalborg PBL model, and the fact that students collaboratively define problems based on real life experiences *and* theoretical knowledge contributes to ownership and engagement in the learning process. Thus, the Aalborg PBL model requires highly interdependent students along with motivating, supportive and facilitating teachers (Ryberg, 2006, Kolmos et al. 2006).

During the *last semester (4th),* students write their master thesis. Ideally, these projects are targeted toward identifying and suggesting solutions to real problems and are therefore potential knowledge contributions. After graduation, we encourage students to collaborate with us on transformation of their projects into research articles when relevant. This has resulted, so far, in article collaborations with six master thesis students, of which two articles have already been published (Glintborg & Krogh, 2015a; Glintborg & Krogh, 2015b), four are under review, three have been accepted as book chapters; and additional manuscripts are currently in preparation.

DISCUSSION: CHaRe AS A NEW APPLICATION OF PROBLEM-BASED LEARNING

PBL can take different forms and vary from institution to institution. However, Hmelo-Silver (2004) suggests that five goals are common for all PBL curricula:

a) Constructing an extensive and flexible knowledge base
b) Developing effective problem-solving and meta-cognitive skills
c) Developing sell-directed, lifelong learning skills
d) Becoming effective collaborators
e) Becoming intrinsically motivated to learn

(Hmelo-Silver, 2004, p. 239-40)

We believe that the CHaRE programme supports students in achieving these goals. The close connection between research, education and practice in the CHaRE programme is aligned with PBL. From our perspective, the PBL-inspiration in CHaRe is evident in that the students are dealing with authentic psychological problems as part of their professional training. Moreover, they are not dealing with real problems from only one point of view, but from multiple (bio-psycho-social) perspectives and must integrate insight from these different scientific fields, as well as draw on general psychological knowledge obtained from their bachelor degrees in psychology (cf. Hemelo-Silver's point a). The structuring of the programme and the supervision during it encourage these integrations.

This way of organizing teaching and learning holds interesting educational possibilities that may generalize. These include how the students become motivated by the different cases, how their learning is structured by clinical practice, how they become prepared for a job after their graduation, and the reduced risk of a so-called "practice shock" (Stokking et al., 2003) (cf. Hemelo's point c). PBL as an educational strategy is characterized by using clients' problems as a motive for students' learning, to acquire knowledge of basic and clinical sciences related to that problem, and to enhance complex problem-solving skills more generally.

Rehabilitation psychologists are trained to engage in a broad range of activities, including clinical practice, consultation, program development, service provision, research, teaching and education, administration, development of public policy, and advocacy related to persons with disability and chronic health conditions. All of this is addressed one way or another in the training that CHaRE students receive during the programme. This training is assumed to also support the development of meta-cognitive abilities (cf. Hmelo-Silver's points b & c).

The initial workshop in CHaRe is based on our research results and the gaps identified in practice. Findings and examples are presented in this workshop. When students are able to see how psychological concepts actually apply to clinical practice, they seem to become more interested and engaged in class, which in turn aids both initial learning and retention of the information. This engagement also tends to increase participation and enhance discussion, which is essential to creating an environment in which students feel respected and valued as learners, and their new knowledge becomes appropriated rather than just learned by heart.

We maintain that all teaching activities (lecturing, seminars and supervision) should be engaging and authentic. We want our students to be inspired and motivated to learn and, furthermore, we want them to be able to apply what they learn during the CHaRE workshops to clinical practice and further develop it in group projects. Therefore, the programme is continuously adjusted in collaboration with the CHaRE students and the Municipalities as we gain new knowledge and experience, and thus students become actual collaborators in the development of the CHaRE programme (cf. Hmelo-Silver's points d & e).

To implement and teach on a PBL-based master programme takes more time than conventional teaching. The curriculum as presented is based on interactive workshops, project work and report-back. The self-directed learning and the time taken for student evaluation means that more time is required by students and curriculum planners for this than for a conventional course. However, the students' learning counter this disadvantage. Students not only learn subject material, but also develop problem solving skills, critical thinking skills and skills for life-long self-directed learning beyond what is usually developed from didactic teaching. Some advocates have focused on the increased levels of student engagement with the subject matter or higher levels of motivation to complete assignments that are meaningful to the students (e.g., Drake & Long 2009; Grant, 2010). This is also something that we see in the CHaRe programme, and it is a pleasure to see that we have managed to evoke great interest among the students, too.

Finally, all five points summarized by Hmelo-Silver as common ground in PBL approaches refer to changes in the minds of students. CHaRE was developed to facilitate these. However, the original formulations of the Aalborg PBL-model went beyond student learning as a change in mental states and competences; students often included actual changes in extra-mural systems in the goals of their project work. Today formulations would be different, but a somewhat similar idea is present in university level strategic goals of collaboration with external partners to co-produce innovative results (cf. Kolmos et al, 2004; http://www.en.aau.dk/cooperation). The PBL-approach of CHaRE also facilitates such combination of student learning and addressing challenges at a societal level. Seeing the gaps and needs in practice is essential in order to educate future psychologists for future needs. We have a strong network and collaboration with the Danish National Board of Social Service and the National Board of Health as well as with local practice. We believe this strong connection is a major advantage for identifying gaps and needs that future psychologists can and should become able to address, as well as for developing and disseminating the means to do so. Developing Rehabilitation Psychology in Denmark with a "whole-person-approach" as advocated by the WHO, and with empirically supported treatments tailored to the cliental, is one example of reaching toward this goal.

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A Case Study of Using Mobile Applications and Peripherals to Encourage "Real-Life" Critical Analysis in Human Physiology

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ABSTRACT

This paper shares a practice of encouraging critical analysis in science students by comparing mobile applications and peripherals to traditional tools to record physiological variables such as heart rate and blood pressure. A progressive series of case studies is described with learning outcomes mapped to the benchmark statement for Bioscience from the United Kingdom's Quality Assurance Agency. A student reflection and staff commentary of the practice is also offered.

Keywords: Critical analysis, mobile technology, reflection, formative assessment, iPad.

INTRODUCTION

Critical analysis is a higher order skill promoted with Higher Education study (Bloom, 1956), and is acknowledged as a key graduate transferable skill for Bioscientists (United Kingdom Quality Assurance Agency (QAA), 2007). Specifically within Bioscience the QAA state that students should have knowledge of *'practical and theoretical methods of acquiring, interpreting and analysing biological information with a critical understanding of the appropriate contexts for their use'.* Despite this critical thought being an essential skill for graduates, it is thought that students find it difficult and may benefit from a case study approach

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to provide context (Herreid et al., 2012). This paper describes a case study approach to developing critical thinking skills in Human Physiology through problem based learning.

CONTEXT

Mobile health (mHealth) is a fast developing area of electronic health (eHealth), and there is now a vast array of mobile health applications (Apps) providing information for a range of health conditions (Martinez-Perez et al., 2013). Furthermore Torous et al., (2004) discovered that more than half of patients are interested in using such applications to learn and inquire about their health. However it must be considered that although some Apps are produced by recognised organisations from the relevant field, the development and sharing of these Apps is, as with some other information on the internet, often unsolicited and can be produced by anyone. This raises an issue in the quality, accuracy and reliability of the information that the general public can access on their mobile devices. In addition to the Apps that act as directories of information, some Apps also claim to collect and interpret physiological measures but offer no information as to their accuracy and reliability. This fact formed the basis of our case study, presented as a staggered approach in the following section.

APPROACH

Stage 1: Staff from the teaching team conducted a research study that acted to validate a number of freely available Apps that claimed to measure resting heart rate (Peart et al., 2014). A class of fifteen level 5 (second year undergraduate) Bioscience and Biochemistry students were introduced to the Apps in a research skills module and then the tutor shared the published article for the group to read. In a subsequent session the tutor facilitated a class discussion that critically analysed the research, and placed into context some of the methods of critical analysis and statistical analysis covered as indicative content for the module. Based on the discussion points students were invited to assist the staff team devise a follow up study.

Stage 2: A group of four students accepted the opportunity to work with the staff team on the second research project (Peart et al., 2015) in a formative manner. The students attended a meeting with the lead researcher to discuss a research design and methodology, which included considerations for reliability, validity and confounding variables. Following this the students were tasked with critiquing the proposed method and making any suggestions. Being involved from study conception also provided the students the opportunity to witness the process of applying for ethical clearance and participant recruitment. Their contribution to the project ended once all data had been collected.

Stage 3: Two of the students involved with step two enquired with the lead researcher about the opportunity to complete an internal work placement, with the aim of validating the accuracy of a mobile peripheral that the department had purchased but had yet to assess (Withings Wireless

Blood Pressure Monitor). The students worked together as a research team to propose and justify a methodology to the staff team, collect the data autonomously without staff assistance, and analyse and present the data in a report along with relevant conclusions. The next section presents a reflection on the process from the student perspective.

STUDENT REFLECTIONS

'Initially we agreed to partake in the research to achieve required placement hours. However during the research aspects beneficial to our personal development were identified and the project became more than just a work placement. We primarily hoped we would gain basic research skills and possibly an insight into research outside of a classroom environment.

We assisted Dr. Peart in a research study likening the sensitivity of three blood pressure (BP) monitors, in the hope of assessing the sensitivity of the Withings' Bluetooth BP monitor. The skills gained during this research included research and transferable skills alike, which are learnt in one area and can be directly applied to numerous other scientific areas (OECD, 2012). One particular skill gained was the use of Microsoft Excel for inputting data and statistical analysis. Once data was inputted we were given advice on how to statistically analyse the data and then left to our own devices, which was challenging but proved fruitful.

Once we had worked out the coefficient of variance for the measurements there was a sense of accomplishment. Statistical analysis was not a skill we felt we had developed earlier in the programme. Statistical analysis is an important skill within research, which Sunal et al (2004) stated many undergraduates lack, and is also crucial when reading and comprehending results from other publications (Bauer, 2009).

According to the QAA (2007), bioscientists should have developed sufficient personal development skills including the ability to critically appraise their own and others work, identify and apply concepts or principles and acquire enough evidence to devise and test hypotheses. We feel all of those skills were enhanced, particularly within the research due to the need to devise our own hypothesis based on previous research.

Although we were both theoretically familiar with the procedure of testing BP using a manual sphygmomanometer, in practice only one of us felt confident enough to execute it practically. In hindsight we felt this particular issue could have been prevented prior to data collection with more meticulous practice, ensuring a smoother execution (Monsen and Horn, 2008). We feel time could have been taken prior to data collection to practice a basic, yet important clinical testing procedure.

During this research we effectively integrated ourselves into a multidisciplinary team and demonstrated the ability to work intuitively and in accordance with demands of applied practice. Although many of the skills mentioned throughout could have been acquired in different ways other than this research project (e.g. by reading how to statistically analyse data using excel), we feel the overall experience was key to our personal development. Research allows undergraduates to understand how the industry works (Castanho and Güner-Akdogan, 2012) and the problematic occurrences encountered gave us a realistic expectation and reiterated that not everything goes according to plan every time.'

DISCUSSION AND CONCLUSION

Stage 1 exposed all students enrolled in the module to the concept of critical analysis, and the presence of the author and technology used in the discussed paper allowed students to put the paper into context. The purpose of this session in the scheme of the module was to facilitate student understanding of research articles. Stage 2 was a voluntary form of formative assessment that was less passive and rather more inquiry based as students were encouraged to begin with a question, investigate a solution and discuss discoveries with other students (Savery, 2006). Such activities may facilitate student learning in context (i.e. outside of the classroom) and meet more of the suggested outcomes from the QAA (Table 1).

Table 1. Mapping the three stages of student participation to the QAA Benchmark Statement for Biosciences

Stage 1
Subject knowledge and understanding • Understanding the applicability of the biosciences to the careers to which graduates will be progressing. *Subject-specific skills* • The ability to read and use appropriate literature with a full and critical understanding, while addressing such questions as content, context, aims, objectives, quality of information, and its interpretation and application • Critical and analytical skills: a recognition that statements should be tested and that evidence is subject to assessment and critical evaluation
Stage 2
Subject knowledge and understanding • Understanding the applicability of the biosciences to the careers to which graduates will be progressing. *Subject-specific skills* • The ability to read and use appropriate literature with a full and critical understanding, while addressing such questions as content, context, aims, objectives, quality of information, and its interpretation and application • Critical and analytical skills: a recognition that statements should be tested and that evidence is subject to assessment and critical evaluation

Intellectual skills

- Apply subject knowledge and understanding to address familiar and unfamiliar problems
- Recognise the moral and ethical issues of investigations and appreciate the need for ethical standards and professional codes of conduct.

Practical skills

- Design, plan, conduct and report on investigations, which may involve primary or secondary data (eg from a survey database). These data may be obtained through individual or group projects
- Undertake field and/or laboratory investigations of living systems in a responsible, safe and ethical manner. For example, students must pay due attention to risk assessment, relevant health and safety regulations, issues relating to animal welfare and procedures for obtaining informed consent.

Communication, presentation and information technology skills

- Cite and reference work in an appropriate manner, including the avoidance of plagiarism
- Use the internet and other electronic sources critically as a means of communication and a source of information.

Stage 3

Subject knowledge and understanding

- Understanding the applicability of the biosciences to the careers to which graduates will be progressing.
- Methods of acquiring, interpreting and analysing biological information with a critical understanding of the appropriate contexts for their use through the study of texts, original papers, reports and data sets

Subject-specific skills

- The ability to read and use appropriate literature with a full and critical understanding, while addressing such questions as content, context, aims, objectives, quality of information, and its interpretation and application

- Critical and analytical skills: a recognition that statements should be tested and that evidence is subject to assessment and critical evaluation
- The ability to think independently, set tasks and solve problems.

Graduate and transferable skills

- Practical skills
- Numeracy skills
- Interpersonal and teamwork skills

Intellectual skills

- Apply subject knowledge and understanding to address familiar and unfamiliar problems
- Recognise the moral and ethical issues of investigations and appreciate the need for ethical standards and professional codes of conduct.

Practical skills

- Design, plan, conduct and report on investigations, which may involve primary or secondary data (eg from a survey database). These data may be obtained through individual or group projects
- Undertake field and/or laboratory investigations of living systems in a responsible, safe and ethical manner. For example, students must pay due attention to risk assessment, relevant health and safety regulations, issues relating to animal welfare and procedures for obtaining informed consent.

Numeracy skills

- Carry out sample selection; record and analyse data in the field and/or the laboratory; ensure validity, accuracy, calibration, precision, replicability and highlight uncertainty during collection
- Prepare, process, interpret and present data, using appropriate qualitative and quantitative techniques, statistical programmes, spreadsheets and programs for presenting data visually
- Solve problems by a variety of methods, including the use of computers.

Communication, presentation and information technology skills

- Cite and reference work in an appropriate manner, including the avoidance of plagiarism
- Use the internet and other electronic sources critically as a means of communication and a source of information.

Interpersonal and teamwork skills

- Identify individual and collective goals and responsibilities and perform in a manner appropriate to these roles, in particular those being developed through practical, laboratory and/or field studies
- Recognise and respect the views and opinions of other team members; negotiating skills
- Evaluate performance as an individual and a team member; evaluate the performance of others

Although stage 2 was more interactive for the students and offered more opportunity for development, it was still predominantly staff directed with some independent reading tasks. Stage 3 however placed much more onus on the students, and was an example of problem based learning as the tutor did not provide information related to the problem (Savery, 2006). The students had to work together as a team to identify literature that would provide a rationale for the research (e.g. Pavlik et al., 2000, Ostchega et al., 2012, Myers et al., 2008, Handler, 2009), and identify similar previous research (e.g. Topuchain, 2014) with which they could justify their chosen methodology. Data collection itself promoted a recurrent approach to practicing skills from other modules, and the analysis of the data also reinforced skills from earlier in the programme (e.g. applied statistical analysis and use of spread sheets). Furthermore the reflection offered in this article encouraged the students to take time to consider how their actions have supported their own learning, and not simply complete the task and move on to something else.

In summary this article shares a series of interrelated case studies that progresses from passive classroom learning to more active inquiry based learning and finally an example of independent problem based learning, with the aim to encourage critical analysis in Bioscience students. The progression of potential learning outcomes have been mapped to the QAA benchmark statement for Biosciences in Table 1, providing evidence of a tiered approach to learning the same topic. Whilst this approach has been considered successful by the teaching team it could be considered that it is not necessarily inclusive across the whole cohort as only 4/15 students participated in stage 2, and only 2/15 students participated in stage 3. Moreover an argument can be made that the students volunteering for stages 2 and 3 may not necessarily be the students who needed encouragement and extra support to develop their critical analysis skills. Methods of initiating and maintaining student enthusiasm for voluntary formative work need to be considered.

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Factors Affecting the Team Formation and Work in Project Based Learning (PBL) for Multidisciplinary Engineering Subjects

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ABSTRACT

The main challenges facing a project based learning (PBL) facilitator in our institution is addressed here in team forming for multidisciplinary PBL subjects of diploma students in mechanical and civil engineering. These challenges include the type of projects, how to team up students, how to proceed with planning, how to swap planning outputs among teams, and how to proceed with implementation of a project. Having executed several multidisciplinary subjects over few years in our institution, a survey was conducted from the facilitators and students at the school of engineering to identify the main concerns of both facilitators and students in creating teams and maintaining teamwork to tackle a real life engineering problem. A questioner consist of 7 questions were distributed and the answers were collected from 10 facilitators and 60 students from both diploma programs. Analyzing the data collected from the survey, the ideal number of students in each team was identified as four students per team; two students from each discipline. Moreover, students believe that they can perform better if they are allowed to select their teammates rather than be grouped randomly by the facilitator. The preferences of students on selecting their teammates was based on the criteria of friendship, hardworking, flexibility in personal character, or being helpful. Moreover, the results of survey indicate that the social/cultural issues such as gender, religion, and ethnicity are also important in forming the teams.

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A DESCRIPTION OF CONTEXT

To prepare the engineering students for the market and real life industrial environment, it is required to encounter them with similar real life work conditions in terms of nature of given project. Multidisciplinary engineering subjects are required to finish an engineering task completely, dealing with people of different and various experiences, education, and skills. Learning methods are needed to be incorporated in student-centered team based learning pedagogy such as project-based, case-based, inquiry-based and problem-based scenarios (Oliver, 2001). The selected approach in our institution is the project based learning (PBL), where certain courses were designed to incorporate students from two or more major engineering disciplines to work together in a real life engineering project and to implement successfully the project while enhancing their learnings and workplace skills.

THEORETICAL AND PEDAGOGICAL FRAMEWORK

The school of engineering at our institution offers a variety of courses based on the PBL approach. Some courses are offered exclusively for students in one discipline where the students work only on one discipline related projects. The corresponding learning outcomes are also mainly related to one engineering discipline. On the other hand, other courses were designed which require multidisciplinary projects and learnings where students are required to form teams and work together, where the work cannot be achieved without the cooperation of students from two or more disciplines within the school of engineering. As stated by Johnson & Johnson (1979,1995), team work help when one student's ideas, information, conclusions, theories, and opinions are incompatible with those of another, and the two seek to reach an agreement. In the literature, many definitions of teamwork are available and according to Scarnati (2001), team work is defined as a cooperative process that allows ordinary people to achieve extraordinary results. Harris & Harris (1996) also explain that a team has a common goal or purpose where team members can develop effective, mutual relationships to achieve team goals. Literature focuses on one of the essential elements of a team which is its focus towards a common goal and a clear purpose (Fisher, Hunter, & Macrosson, 1997, 1999; Parker, 1990; Harris & Harris, 1996).

In this work, the challenges for the single and multidisciplinary courses utilizing a PBL approach will be discussed. The results of a survey on team forming are also demonstrated from responses of both facilitators and students.

CONCRETE IMPLEMENTATION AND ACTION

One of the multidisciplinary courses in our curriculum is "ENEG12006 - Engineering Design and Management Implementation" where mechanical and civil engineering students are working together on a real industrial problem. The first step in this course is to form a team with equal number of mechanical and civil engineering students. However, this step can be performed either by random selection of the students in each team or allow the students to select their teammates. It should be mentioned here that the number and size of each team depends on the total number of students in the class.

In PBL, to resemble a real life work environment, a random selection procedure is recommended, but this procedure may face the following challenges:

***Culture*:** Mainly if there are male/female students in the same group, as some students (from different gender) may refuse working with the opposite gender. So, allowing students to select their teammates will solve the issue.

***Personal*:** Some of the students may feel very shy if they work with others if they do not know or have previous friendship.

***Scientific/Knowledge*:** Random selection of the group members by the facilitator may result in an uneven experiences in one team, while allowing students to select their teammates based on their needs to finalize the project can result in a better performance. For example, using computer and up to date technologies in solving the problem like 3-D printing and engineering software like ANSYS is mandatory in getting high evaluation of the learning outcomes of the course. Due to the difficulty involved in the design and development of complex software systems, wide ranges of software engineering paradigms have been developed, such as object-oriented programming, structured programming, procedural programming and declarative programming (Genza & Mighele, 2013). If the students selected their teammates based on their previous knowledge and skills can result in better performance than forcing the team to work with same skills and experiences.

***Nature of the project*:** Some projects need professional skills in workshop activities, in which mechanical engineering students may perform better than civil engineering students and even within the same discipline some students are more skilled and handy in doing practical jobs than other students.

Based on the above mentioned reasons, it is better to allow the students to select their mates only on the first phase, i.e. the design phase, whereas in the implementation phase, the facilitator can randomly assign a team to implement the design of other teams to give the students a flavor

of real life environment. Even if the students are allowed to generate their teams by themselves, many problems arise such as the inability to reach agreements, lack of innovative ideas, conflicts, or complacency of team members.

To help the facilitator in delivering the course in its best way, our registrar office should facilitate enrolling a balanced number of students from each discipline.

***Communication skills*:** Some of the students are professional and active in communicating with other people inside and outside the college. Communication in their team, with other teams and with the instructor are very important and different communication means should be used, such as verbal and written communication, since they contribute to achieve ten learning outcomes. For instance, the 10th learning outcome in ENEG 12006 states: "Provide evidence of a professional capacity to communicate, work and learn; individually and in peer learning teams".

RESULTS AND REFLECTIONS

To determine the best way to form teams in the aforementioned multidisciplinary PBL units, a survey was conducted in which facilitators and students were interviewed on the following questioner consist of 7 questions tabulated in Table 1. The participated numbers of facilitators were 10 while 60 students attended the survey.

Question	**Answer**	
	Students	**Staff**
1) What are the three most difficult challenges in building student teams? (most difficult first, least difficult last)	**Most Difficult:** • Nationality. • Age. • New members (not acquainted with)-Friends-Knowing our teammates-Friends that we have to choose. • Not enough students from the other department. • Choosing the team knowledge. • Finding chemistry between members. • Different cultures and different way of thinking. • Team dynamics. • Being in class without my friends. **In between:** • Gender (*mentioned 4 times*) • Not being acquainted enough with other students. • Teams members that work. • Assigning tasks.	**Most Difficult:** • Unequal number of civil & mechanical students. • Some students are not welcome in groups due to either unprofessional behaviour/bad experience. • Ensuring effective teamwork. • Social interest. • Culture sensitivity. **In between:** • Academic levels. • Balance in disciplines. • Gender. • All good students want to team up together.

	• Time schedule. • Team dynamics. • Time management. • Communication • Those who don't work or do every effort. **Least Difficult:** • Age (*mentioned 2 times*). • Different approach in doing things. • Friends. • Getting the full workload. • Mix group. • Knowledge. • Time management. • Chemistry.	• There are weak students who want stronger team. **Least Difficult:** • There are undecided students unsure. • According to their needs • Having the team agree on topic • Being responsible. • Assigning students to teams.
2) What is the most suitable number of students in each team? Why?	*Ranked from top to down according to most favored answer.* 4 members in one team: • Easy to communicate. • Ease to distribute tasks fairly and equally. 5 members in one team: • Distribution of work and saving time. 6 members in one team: • More idea generation. 3 members in one team: • To be able to focus on tasks with all members working. 2 members in one team: • Less stress of coordination. 1 member in one team: • To get the entire knowledge of PBL	*Ranked from top to down according to most favored answer.* 4 members in one team: • Two department for multidisciplinary. • Every group will have 2X2. • Enough work for each students • Equal number of both majors. 4-5 members in one team: • Less makes it difficult and more means less people work. • Everyone needs to contribute. 3 members in one team: • Students interact more efficiently. 5 members in one team: • Diversity 6 members in one team: • Equal numbers
3) The performance of teams is better if they select themselves than if I assign them to teams.	Most answered with Yes 1 answered with No	7 answered with Yes 3 answered with No
4) If you assign students to teams, how do you assign them?	• Based on reputation of hard work. • Strong knowledge with good manners. • If I know them or not. • Based on their thrust for knowledge • Helpful • Based on their disciplines and skills.	• 2 civil + 2 mechanical • Diverse • According to their major-Combination of different department • I should know them in advance to team up fairly based on their background. • Equal distribution between disciplines.

5) Teams perform better if all team members are equally strong. Why?	All answered with Yes: • Mutual help • They know what to do. • Keep same pace to all members. • Competition. • Better outcomes for the project. • Save time. Respect their work and others.	3 answered with Yes: • The team strength is driven by its members. • They should have enough strength in different fields. 7 answered with No: • More conflict.
6) Teams perform better if a team consists of a mix of strong and weak students. Why?	*The answer was equal between Yes, No, and sometimes.* Students answered with Yes: • Help each other and work together. • They can accomplish more • Learn from each other. Students with No: • Lack of experience. • Strong ones land doing the job alone. • Mis-communication. Students answered with sometimes: • If the weak students are willing to learn.	7 answered with Yes: • In some cases, weak students work harder to reach the level of strong students. • Yes diversity • Yes, because weak students may perform better • Yes, weak students will work hard to catch-up 3 answered with No: • Weak students affect the performance. • If good team culture exists.
7) When you have interdisciplinary PBL courses, do you prefer to have equal number of students from the two majors in each team? Why?	Most students answered with Yes: • Skills exchange • Faster performance of work. • More idea generation. • Divide tasks equally. • Learn more • Each focus on their expertise. 2 answered with No: • Mechanical students can do the job alone.	7 answered with Yes: • Knowledge exchange. • Avoid bias. • Equal resources for all teams. • Easier to build groups/tasks distributed fairly. • Allows sub-teams for discipline work. 1 answered with No: • Diversity 2 answered with Not sure: • Depends on the students and work required from them

Table 1: Survey results

The results are summarized in table 1. It can be clearly seen that the social/cultural issues are the main challenges in forming the teams, as some of the students refuse to work with others for reasons such as social issues like gender, previous experience, and friendship. It was highlighted by the facilitators that most difficult challenges in building a team is having unequal number of civil and mechanical students while the least difficult challenge is assigning students to teams.

According to PBL facilitators and students, the best size for a group is four students equally divided among participating disciplines. In addition, the facilitators reported that if the students

selected their teammates, they will perform better. Majority of facilitators (7/10) prefer distribute equally across disciplines to ensure fairness and equal distribution of tasks; others (2/10) prefer to distribute them according to the students' experience and skills.

Regarding the performance of the team, students strongly agree that the team performs better if all team members are equally strong whereas most of facilitators disagree with the students because students may tend to have conflicts in this situation. Since strong students usually have a higher intention for leadership and considering the lack of conflict resolution skills (Aarnio, 2013), having multiple strong students resulted in initiation and aggravation of personal conflicts amongst team members during the semester which impacted the team performance negatively.

Different responses were noticed when students with mixed levels are in one team as the majority of the staff noticed better performance because that allows the students to share ideas and this gives the opportunity for the weak students to catch up. The students get suitable support from their colleagues which is part of the learning outcome "lifelong learning". Others observed negative effects among the weak students as they will not keep promises of doing their work and cause a delay in team work in addition to being very dependent.

CONCLUSIONS AND RECOMMENDATIONS

This paper has explored team forming of multidisciplinary PBL subjects in School of Engineering by surveying the PBL facilitators and the students. It has addressed the challenges that the students and staff face in team formation such as social/cultural issues, members distribution according to their background, and students preference in working with people they are acquainted with. The most preferred size for each group was suggested by most of the interviewees including facilitators and students are four students per team. Due to the lack of experience in team formation among students, this paper recommends that students' awareness on team formation should be raised prior to encountering with teamwork. This would enable them to select their team members wisely and based on accurate rational to facilitate their individual and team learnings.

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Re-focusing the Creative Process: Blending Problem-Based Studio Practice and Online Reflection

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ABSTRACT

To promote the development of greater creativity in my students' design work, I created an online tool—called Reflective Inquiry (RI)—that accompanies all of my open-ended assignments and that I require students to submit with each project. The RI is composed of a series of prompts that students must respond to, almost daily, to explain and illustrate their thinking processes and decisions. I ask students to think critically about questions such as "what don't you understand about this assignment?" "what materials are you exploring?" and "why these materials?" In addressing a series of questions about basic ideas, historical research, materials, production, and future application of concepts, students articulate their thinking, acknowledge their confusions, identify creative concepts, and observe their own artistic development. Being digital, RI can house student audio and video examples of their work in progress as well as serve as a dynamic platform for critiquing and classroom sharing.

INTRODUCTION

I teach an Introduction to Design Foundations course that is a pre-requisite for all other courses offered in the art and design department. My classroom consists of students in different departments as well as art and design majors. In an attempt to teach design to this diverse student body I have implemented a problem-based learning pedagogy and created a methodology for teaching introductory design courses—using an online tool I call Reflective

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Inquiry (RI)—that has broadened my instructional capability, deepened my students' classroom learning, and expanded their creative experience.

The Reflective Inquiry documents my students' gained knowledge, skills, and 'time on task' to investigate and respond to authentic, engaging and complex questions, problems, or challenges my assignments present by requiring students to digitally document their entire thinking, research, and production. The RI, a series of specific prompts, is integrated into the Learning Management System (LMS), leading students through sections that are revealed individually as they work their way through each project. Each unit contains questions that correlate with the stages I have identified as crucial to the creative process.

Combining face-to-face classes with online prompts creates more opportunities for communication and feedback than are possible in a traditional classroom. Placing the RI online provides a private space for student exploration and individualized instruction as well as a public platform for classroom dialogue to occur. RI documents my students' educational experience for assessment purposes as well as so that students better understand their capacity for creativity and imagination.

CONTEXT AND AIMS: DEVELOPING SELF REFLECTION

Developing the ability to reflect on a project is essential to students learning how to explore ideas, navigate mistakes and failure, and make meaningful artwork. Through RI I can validate not only the end results of an assignment but also the discarded attempts, disqualified ideas, and unproductive accidents encountered along the way. Inspired by and based on the premise that one learns more from failure than success, RI broadens my assessment to include documentation of a student's understanding of the art elements and principles of organization by way of self-reflection, critical analysis, and problem solving.

The RI is a list of questions discussed daily during each stage of students' assignments. Students work on their project as well as their RI simultaneously. Both are reviewed at the end of a project and are given equal weight in their project's final grade. Research shows that,

> without guidance, structure, and support, learners may be overwhelmed by the complexity and struggle to make the most of their learning experience. Reflection supports learners to make sense and meaning from their experience and at its most critical level, contributes to transformative learning……. Supporting learners to develop their capacity for reflection and structuring opportunities for reflection before, during, and after the experience will enable learners to navigate the inherent complexities of learning through experience (Coulson & Harvey, 2013, p. 403).

Much has been written about the need to have students think about their learning and reflect on their experience, and the means of encouraging such reflection is usually through journal writing of some kind (Hoffman, 1983; Commander & Smith, 1996; Cantrell, 1997; Walden, 1988). This form of writing during and after activities generally gets no further, though, than asking students what they expect to get out of an activity, what their behavior was during the assignment, and what they feel they learned from doing it. Walden carries the notion further, by fashioning specific questions based on classroom discussion and readings, but doesn't scaffold the development of student thinking in a specific discipline. In art education, Walker (2004) has students write about their projects without giving specific guidance as to how to do this, and Stout (1993) emphasizes the need for students to keep what she calls a "dialogic journal," which is a loose "synthesis of a diary, classnotes, and the fieldnotes of a naturalist.... It is a place for their emerging voices, where ideas about creation and response are uncensored and as speculative, unique, and as wild as they wish" (p. 40). As to how to help students do this effectively, Stout suggests letting them study other artists' journals. And even in the most comprehensive discussion of using journals to guide reflection, Moon (1999) summarizes structured forms in a page, suggesting that questions "might ensure that appropriate areas of material are covered" (p. 195).

The more systematic approach of RI is intended to mirror the thinking processes students need to internalize as working artists and is a form of the 'reflective practicum' "aimed at helping students acquire the kinds of artistry essential to competence in the indeterminate zones of practice" advocated by Donald Schön (1987) in Educating the Reflective Practitioner. RI helps students understand what kinds of questions they need to ask themselves to keep moving ahead; it is a form of self-coaching in which the questions serve as the framework for the student to learn from ineffective thoughts or unproductive actions and turn them into experiential knowledge. Working independently through RI, students are able to address and resolve more questions than can be explored daily with an instructor in the classroom. Completing the RI prior to a critique facilitates the student / professor dialogue, provides a springboard to deeper learning, expedites the critiquing process, and ensures an overall higher level of communication and exchange of ideas.

DIGITAL FROM START TO FINISH

Delivering RI's through an LMS facilitates several different modern educational strategies such as self-directed learning, collaborative learning, experiential-based learning, and active learning. The digital format allows my students access to this educational space from any location and device capable of connecting to the Internet. My students can insert photos or videos of their projects and housing digital files within the students' RI's written prompts helps me to use them as teaching tools. The dialogues I have with my students are facilitated because the students' responses are readily accessible, organized, and sequential.

Making the RI digital allows my students to directly hyperlink to websites of influential artists and artworks. Students are able to build a digital sketchbook for their ideas. Once a student places a file into the RI, I can post comments, critiques, and grades. The site is secure and each student only has access to his or her own area as well as an open forum for group and class sharing. Assessing student performance is easier and faster because everything (such as cited websites, thoughts, and images) is in one location.

The RI consists of over a hundred prompts and is divided into eight sections: brainstorming, historical research, final idea, dialogue with materials, production, post production reflection, knowledge, and future accomplishments.

The following is a brief example of how a former student (I'll call him "James") worked through his Reflective Inquiry to complete the assignment previously mentioned. Confronted with an open-ended assignment James used the RI to work through each stage of the problem and document his thinking.

BRAINSTORMING

The first question of the RI asks students if they understand the assignment and requires students to brainstorm and generate as many ideas as possible. Upon completion of this section, students will have well developed, focused, and clarified ideas to discuss in class as well as a better understanding of what a successfully completed project entails. In order to brainstorm, James brought several images to class and we discussed how he might reproduce the artworks using Photoshop or collage as media, reformatting the images as magazine cover pages or advertisements, re-contextualizing the artworks as Facebook or Twitter postings, or replacing kings and queens in compositions with new tabloid or pop culture personalities. James chose "Composition II" completed in 1930 by Piet Mondrian and wrote that he was originally introduced to the image in his art history class; he immediately responded to Mondrian's use of formal visual language such as repeated simple geometric forms, color, variety, and grids created by the linear quality of the intersecting black lines.

HISTORICAL RESEARCH

Creating a visual library through their research, students can see how previous artists have resolved design problems, as well as apply what they learn to ideas or issues they wish to employ. Identifying concepts and attempting to resolve complexities can lead to creative breakthroughs, since, as Sawyer (2012) notes, "Creativity involves a combination of two or more thoughts or concepts that have never been combined together before by that individual" (p. 7).

In his RI James wrote that Mondrian favored pure red, yellow, and blue as well as black and white colors separated by thick black lines. Over time his artwork became cleaner and simpler until finally culminating in strong fields of color without the use of black lines to separated them. James reflected on the importance of Mondrian's color field series and its reliance on formal design, and explored a variety of media (tissue paper, construction paper, newsprint, and acetate) to contemporize Mondrian's design concept, which he documented in his RI with examples.

FINAL IDEA

Encouraging my students to work through the RI prior to class helps to edit many of their ideas down to a few manageable ones we can discuss. For James, the big question was: "How do I contemporize Mondrian?" Answer: Duct Tape!! James reflected on how Duct tape was perfect for making straight lines, could be cut and applied to create desired squares and rectangles, and is manufactured in a selection of colors other than silver. He discussed how painters often lay down tape to create straight lines, so the connection to Mondrian had multiple associations.
Dialogue with Materials

The Dialogue with Materials section requires students to think about which materials and how materials could be used to execute their artwork. As Sawyer (2012) notes, "Creativity takes place over time, and most of the creativity occurs while doing the work. The medium is an essential part of the creative process, and creators often get ideas while working with their materials" (p. 89). This section helps students develop a broader and often unique understanding of how to use the materials. Through their research most students have compiled some thoughts on materials previously used and often have already watched informational videos on how to work with various materials, the tools required, and suppliers.

James possesses a lot of technical skills; initially he thought the process of applying Duct tape was going to be quick and easy. Several hours later, a pile of tape adhered to itself, ripped poster board surfaces, and created irregular lines and overlapped seams; James realized the Duct tape demanded more respect than originally given to it. Also, creating an original design that referenced Mondrian's artwork by applying the "Golden mean" (a concept he recently learned in class) took a lot more time to resolve than he originally thought it would. James used colored pencil to resolve his final design on paper because he had wasted a lot of tape underestimating its adhering quality (especially onto itself), the difficulty of laying it in a straight line without getting air bubbles or creases on its surface, and that although scissors were easier to use than a straight blade they proved harder to control, resulting in uneven edges of tape. Solution? Overlapping the tape. Next problem—how to sequence the application of tape. As James worked through the various problems he confronted, he used the RI to resolve the issues that arose, taking photos to document his process, failures, and results.

PRODUCTION

Since I have chosen to focus my instruction on developing an idea and finding the best materials to support this idea, more of the production component of projects has fallen onto students. To address this and meet their needs I have focused more on instilling in my students the ability to be self-learners as they confront the availability and costs of materials, skills required, and project deadlines. Teaching my students to think through an assignment from start to finish, identify their project needs, and obtain resources are important skills they will need as they matriculate and start careers as professional artists.

Final production commenced after a short trip to the local hardware store to purchase tape and the local art store to purchase Bristol board. Executing the project went well because James spent many hours making test examples and resolving his design in his RI prior to starting his project.

POST PRODUCTION REFLECTION

In the RI Post Production Reflection section, students are asked to reflect back on how to improve the production component of their assignment. Their insights can be as simple as critiquing a new technical skill or as complex as improving their communication with others. Here the student is reviewing the appropriateness of and their facility with materials during production.

In reviewing his final project, James reflected that a thicker Bristol board would have remained flatter and been more durable; also, that making more accurate measurements and drawing lines to follow (in addition to the pencil marks) would have provided much needed guidelines and following them would have helped to keep the tape straight. Overlapping the tape caused an unintentional secondary line that needed to be straight as well. Using a mixing spatula to rub the tape blemished its surface. In his RI he noted that were he to remake the project he would wrap the spatula in a cloth to protect the tape's surface. Trying to place the tape's edges beside one another grew harder as the length of the tape increased. Uneven tape edges showed through even though the tape was layered. In his RI James noted all of these difficulties and proposed potential solutions were he to repeat this project; he also explored how these difficulties and solutions related to other design issues.

KNOWLEDGE

In their rush to finish a project students overlook the benefits and sequence of my assignments, which is not simply to just bring more objects into the world. I consider their projects a byproduct of my assignments. Quite often they are pretty wonderful byproducts, but my main focus in my foundations classroom is not to produce craftsmen as much as it is to help students

master domain knowledge so that they are prepared to be creative using that knowledge as designers and artists. As Sawyer notes, "A creative insight that generates good questions is more valuable than one that conclusively answers every known question but doesn't suggest any further research" (p.138).

James listed many more insights than those I've mentioned here. I've separated them into a few major categories; he learned about: Mondrian the artist, Abstract art, the Modern art movement, the primary colors, the "golden mean" as a way to divide space, the proportional ratio of color fields in relationship to the thickness of tape (mathematical ratios and calculations), where to purchase Duct tape, calculating how much tape will be needed and how much to purchase, the history of Duct tape, how to best cut Duct tape, and sequential thinking.

FUTURE ACCOMPLISHMENTS

The questions in the Future Accomplishments section help students transfer knowledge to future projects. I agree with implications drawn from studies done by Mayer "that to assess for creative learning, students should be tested not only on retention of specific facts, but on the ability to transfer knowledge to new problems" (as cited in Sawyer, 2012, p. 401). My students are building a knowledge base having used the RI to successfully resolve actual or hypothetical design issues. These insights become recognized solutions and this is knowledge they apply to future projects.

James, whose major is painting, wrote in his RI that he could improve his craftsmanship by using pencil lines to follow and ensure they are straight. He also learned that by painting the edge of a piece of tape with clear paint first (before applying a color to an area and removing the tape) keeps paint from "bleeding" underneath tape. In larger conceptual terms, he broadened his experience with making art, better understands the history of art, and is learning what it takes to be a professional artist; as he stated, "I really like formal language and now understand modern art much more than before I took this class."

RI AS AN ASSESSMENT TOOL

To document the artistic growth, skill development, thinking skills, and to validate the "total" learning that has occurred throughout the semester each assignment measures creativity in five distinct ways: (1) students complete a self-assessment questionnaire; (2) grade their own project and turn in a completed RI; (3) during the critique students issue a written grade for every artwork presented by their peers including their own (which I average for one 'class grade'); (4) after the in-class critique I collect the student projects and create a verbal critique captured as a Quicktime file that is posted in the LMS; (5) finally, I developed a rubric to assess their RI. This rubric assesses the students' attention to and engagement in the creative process by measuring my students' understanding of the assignment, the quality of their historical

research, how they resolved their final idea, their material explorations and decisions, their post-production reflections, documentation of knowledge gained, and how this knowledge might potentially be used in the future.

I have compiled inter-rated reliability documentation from fifty-six assignments over the last three years to confirm the validity of RI as a tool for documenting the complete learning that occurs in a creative process. The relationship between the five aspects of assessment that occur with each assignment are consistent. This year I have solicited design professors to assess and compare the creativity of my students' first project of the semester (created without using the RI) to their final project of the semester (created using the RI) as an external measure to further validate the inter-rated reliability results and to further confirm the creative development of the students.

In regard to James's project, the results of these five methods of assessment provided a clear picture of the extent of the learning that occurred. The other students and I thought translating Mondrian's painted squares into Duct tape was a wonderful and creative way to contemporize a classic work of art. The fact that James suggested various improvements was more important to me than the craftsmanship of his final project. In the RI he demonstrated that much more learning occurred than could previously be assessed just from the final project. He illustrated his thinking process at every step, documenting his attempts and reasoning (often with photographs or videos) and explained his rationale for decision making even when the results were not completely successful. The RI documented the unfolding of the problem presented to James as he worked through each step required for a satisfactory solution to an assignment without an easy or defined answer.

CONCLUSION

The RI provides a structure for my students to independently reflect on and work through open-ended problem-based assignments, developing higher learning skills and becoming independent learners. In addition, it provides me with a means to assess the learning that occurs throughout the creative process. RI provides evidence that specific knowledge, skills, and techniques relevant to making art are being learned.

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Assessment for Project-Based Courses

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ABSTRACT

A project-based course is where students engage in a series of projects, which help lead students to a defined level of skill as specified in the course goals. Unlike a traditional lecture course where students are given examinations to assess the level of student knowledge and understanding, a project-based course may not include any formal examination. The assessment of student progress is often based on the quality of course projects. For this research, students in project-based courses were given a formal exam at the end of the course. The objective of the exam was to determine if there was a discrepancy between student performance on the exam and their projects. While the majority of students performed remarkably similarly on their exam and projects, a number of students (25%) did perform quite differently. This study demonstrated that examinations are still a critical tool for assessing student skill level in project-based courses.

Keywords: project-based learning, PBL, assessment, examination, SOTL.

INTRODUCTION

One of the key functions for a college instructor is to observe and assess the process of learning in which their students are engaging. Without the ability to conduct an accurate assessment of student learning, the teacher would have little ability to judge the effectiveness of the education

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in the classroom. "Classroom Assessment helps individual college teachers obtain useful feedback on what, how much, and how well their students are learning. Faculty can then use this information to refocus their teaching to help students make their learning more efficient and more effective." (Angelo & Cross, 1993, p. 3) Without evidence that substantive student learning has taken place, then the teaching experience has been incomplete. "Teaching without learning is just talking." (Angelo & Cross, 1993, p. 3)

For many college courses, the general classroom pedagogy has been moving away from traditional lecture classes and towards a more stimulating and hands-on learning environment. This trend will likely continue as studies show that active learning methods are significantly more effective than lecture courses. (Freeman, et al., 2014) In a project-based learning (PBL) course, lectures and examinations are minimized or eliminated altogether, and student assessment is largely based on the quality and accuracy of students' project work.

A broad description of project-based learning, developed in 1975 by Adderley et al., is still in use today. To summarize, PBL involves initiative by the students and various activities, which commonly result in an end product such as a report, design, or presentation. The project varies in length from one class period to several weeks, and the instructors are often involved in an advisory role, rather than an authoritative role. (Adderley, et al., 1975)

In 1983, educator Alistair Morgan developed three general models of project-based education. First is the Project Exercise model, where previously acquired knowledge and skills are applied to a project. This model is typical for a capstone course where students demonstrate and utilize knowledge and skills that they developed in previous coursework. The second model is the Project Component, which is taught in parallel with traditionally taught courses. Here, students are given an opportunity to apply information from other courses to real-world problems, thus reinforcing the information students have learned. The third model is the Project Orientation model, where the entire course is delivered in a project-based format. Students gain knowledge and skills through the variety of tasks related to the project. To the extent that direct instructional teaching occurs, it is only used to supplement the requirements of the project. (Morgan, 1983)

The motivations for adopting a PBL-oriented curriculum are varied. Gunter Heitmann identified four general motivations for engaging students in a PBL environment. The first motivation is to mimic real-world practice, where students experience problems-solving situations that they may encounter on a job. Second, PBL gives students experience working in a democratic situation, where students must work together in a spirit of cooperation and conflict resolution in order to accomplish a task. Third, students engage in tasks that will foster critical thinking skills, by requiring students to analyze a problem and to apply an appropriate solution. Fourth, PBL is pedagogical, where students accomplish their learning and skill development through hands-on experiences. (Heitmann, 1996)

In addition to the models and motivations for project-based learning, one must also consider the types of projects in which students will engage. In 1921, a pioneer in PBL, William Heard Kilpatrick, distinguished four types of PBL projects. The first type encompasses experiential learning. These projects provide students with the experience of doing, making, or affecting something to embody an idea in a material form. The second type simply involves students in the purposeful enjoyment or appropriation of an experience. The third type is one whose primary purpose is to solve a problem. Students apply their existing knowledge and experience to a problem situation and develop a solution. The final project type is the learning project, where students acquire new knowledge or skill through their engagement with project tasks and assignments. (Kilpatrick, 1921)

The Computer Aided Drafting Technology (CADT) program at the National Technical Institute for the Deaf (NTID) delivers most of its technical courses in a studio, using a project-based learning format. Of Morgan's three models of project-based learning (Morgan, 1983), the CADT program uses the Project Orientation model. Students learn specific skills by engaging in project assignments, either individually or with a group. The motivation for this model is Heitmann's Pedagogy Motive, where the students are learning their skills through direct hands-on experience with the software. Finally, the project type used for this program is Kilpatrick's Learning Project, where the purpose of the project is to teach specific skillsets.

Because of the PBL nature of the CADT program, the assessment of student learning is largely based on the students' projects. The projects may last only one or two class periods, or they may be larger projects lasting up to half the semester. Traditionally, the CADT program does not give any type of formal testing of student skills. Instead, a student's course grade is mostly based on submitted projects, with a smaller percentage calculated from attendance and various homework assignments.

Throughout the semester, the students receive formative assessments from the instructor for each of their projects. A formative assessment provides the student feedback that is used to guide him or her on subsequent projects, as opposed to a summative assessment, which is simply a judgment on the quality of the student's work. (Taras, 2005) Traditionally, the CADT program does not conduct a summative assessment at the end of the semester to determine a more precise determination of the students' level of skill. Instead, the semester's formative project assessments are generally deemed to be sufficient information.

The question addressed by this paper is whether or not relying only on project assessments tells the complete story of the student learning that took place during the course. The course grade should provide a reasonable indication of the student's skill level achieved during the course. But does it? Is it possible that the grade earned by the student does not give the complete picture? Are the student's project grades alone sufficient to determine the student's skill level

as reflected in his or her course grade? To answer these questions, an experiment was conducted on several project-based courses.

METHOD

Participants

Six courses were selected over a two-year period for this study. These courses were identified as specifically using project-based learning, and relying on assessments based almost entirely on the quality of student project work. Four of the six courses were taught in the CADT program at NTID with only deaf and hard-of-hearing students, and the other two courses were taught in the Interior Design program in the College of Imaging Arts and Sciences (CIAS) at RIT with mostly hearing students. The participants were first-year and second-year college students. All of the courses taught various computer applications, including Autodesk AutoCAD, Autodesk Revit, SketchUp, Adobe Photoshop, and Adobe InDesign. The typical class format included a brief introduction and a demonstration by the instructor, followed by an in-class assignment to be completed independently by the students. Students then applied these skills to a project, to be completed either individually or as part of a team. The projects also varied in length of time, from one to several weeks. The projects were evaluated and graded, and the students' course grades were largely based on the accumulated project grades.

Procedure

As part of this research, the students were given a formal examination at the end of the term. The examination asked students to complete a small project using many of the skills learned during the term within a two-hour time frame. The format of this exercise was similar to the 'triple jump' assessment, which was developed to assess both knowledge and problem solving abilities. (Painvin, et al, 1979) During the first stage of the 'triple jump,' students received the problem description and requirements. No more than fifteen minutes were needed to determine a plan of action and the appropriate software tools needed for the solution. The second stage involved the execution of the solution, which consumed the bulk of the exam time, approximately one and a half hours. The third stage, for the final fifteen minutes of the exam period, students documented their solution by printing and submitting their drawings.

The exam's project was carefully created to mimic the type of projects on which the students had worked previously, albeit on a much smaller scale. It was important to avoid the kind of "mismatch between assessment and learning" that sometimes plagues PBL assessments. (Savin-Baden, 2004, p. 230) In this case, the key differences between the exam project and the semester projects were that the exam project had to be completed independently and within a two-hour time limit.

The purpose of this additional assessment was to see how well the students performed on the exam compared to the quality of their course projects. If there was a difference of more than a few percentage points, an attempt was done to ascertain the reason for the discrepancy. A grade difference of at least 10% (i.e. a full letter grade) was thought to be significant enough to warrant further investigation to determine the reason for the inconsistency. Table 1 shows a summary of the results of this experiment.

Course	*Course Name*	*Number of Students*	*Number of Students Affected*	*Percentage of Students Affected*
A	Construction CAD I	14	5	36%
B	Interior Design AutoCAD Elective	14	3	21%
C	Engineering Graphics in AEC	8	1	13%
D	Graphics for CAD	6	3	50%
E	Construction CAD I	7	1	14%
F	Interior Design Elective	18	4	22%
	Total	67	17	25%

Table 1 Summary of Results: Students Impacted by Formal Exams in Project-Based Learning Courses

RESULTS

For Course A, as shown in Table 1, the final exam grades were substantially different from the course projects grades for five of the fourteen students (36%). Four students performed poorer on the final exam compared to their course project grades, while a fifth student performed better. Two of the four students who performed worse were students who worked hard, but relied heavily on assistance to complete their projects. When asked to perform independently on the exam, they struggled. The other two students appeared to do well on their course projects, but did not perform well under the time limit constraints of the exam. Conversely, the student who performed better on the final exam was a student with strong skills, but got behind and frequently turned his work in late.

In Course B, two of the students affected by the final exam did noticeably worse on the final exam than their project grades, and one student did better on the final exam. The other eleven students received grades within three percentage points of their project grades, which shows that the skills demonstrated on the assignments accurately reflected their actual skillset. The two students who did poorly on the final exam required a significant amount of assistance, and they were persistent in getting the help they needed to complete their projects. The one student who did better on the final exam was a capable student who slacked off during the second half of the course.

The data for Course C showed a remarkable correlation between the students' project grades and their final exam grade. There was only one student who had a marginally significant difference. This student was a strong student who likely did not give much effort for the final exam with the knowledge that it would not have much impact his final course grade.

The three students impacted by the final exam in Course D requested a lot of assistance on their projects, and they often insisted that their projects be "pre-graded" before actual submission. The final exam demonstrated that they had not developed sufficient independent skills; instead their project grades tended to overemphasize their effort, rather than their actual skills.

The results for Course E were similar to Course C in that there was little difference between the final exam and the project grades. The one student who was impacted by the final exam was a hardworking student who would spend many hours in the CAD lab outside of class to work on her projects. She struggled with many of the concepts taught during class, but, to her credit, she would persevere with the course projects on her own time, while frequently requesting assistance. This student was unable to complete her final exam given the time limitations.

In the final course listed in this study, Course F, three of the four students affected by the final exam were also students who most frequently requested assistance to complete their assignments. Thus, they struggled when asked to complete the final exam independently. The fourth student did surprisingly poorly on the final exam even though she was an exceptional student during the course. Perhaps she did not take the final exam seriously since she already had a high course average.

Summary of Results

The above research shows a somewhat consistent result. Of the sixty-seven students in six courses included in this study, seventeen of them (25%) performed considerably differently on the final exam than they did on their course projects. Many of these students worked hard, but they found the material challenging to comprehend, and because they wanted good grades, they frequently requested assistance from their instructor or their classmates. However, when the final exam required them to work independently and within a limited time frame, they were unable to complete the work at the same standard that they met on their course projects.

The majority (75%) of the students in this study completed the final exam as would be expected based on their course projects. 'A' students earned an 'A' on the final exam, 'C' students earned a 'C' on the final exam, and so on. For these students, the final exam served to validate the student's skill level. For the other quarter of the students, however, the final exam did illustrate some valuable information about their skill level. In a few cases, students performed considerably better on the final exam, which indicated that they have strong skills, but they did

not take their course responsibilities seriously. For most of this group, however, students demonstrated less skill development than they apparently showed in their project work.

One student who did not perform up to expectations on the final exam admitted that if the final exam had been emphasized during the semester, he would have applied himself more earnestly to learn and internalize the skills being taught. In other words, his focus was not on the acquisition of skills but on simply completing the projects for a grade. Without an impending requirement to demonstrate the skills, some students simply lacked the will to develop their skills at a higher level. The self-motivation of the student to commit oneself to success is an important component of a PBL curriculum. (Van Berkel & Schmidt, 2000).

DISCUSSION

An important consideration for determining the appropriate type and level of classroom assessment is to clarify the meaning of the course grade. For the CADT program, the desire is that the student's course grade should reflect their skill level as well as their effort. However, using the program's traditional method of basing the course grade largely on project grades, the grade emphasized the student's effort too heavily, and it did not necessarily reflect the student's actual skill level. A prospective employer rightfully would expect that an 'A' student should be capable of performing superior work on the job. Therefore, the course grade ought to accurately reflect the student's actual skill level.

Admittedly, too much emphasis on the course grade can become problematic for PBL courses. A singular focus on grades "can encourage students to adopt methods of learning which ensure they pass the course with high grades, rather than to adopt learning approaches that would be in their best interests." (Savin-Baden, 2004, p. 231) Nevertheless, when the primary objective of the PBL course is to acquire a defined skillset, a means to assess that acquisition becomes a critical component of the course grade.

The other key lesson from this research is the importance of assessing students' ability to work independently. A valuable employee is one whom the supervisor can rely on to complete a task correctly, quickly, and independently. An employee who relies too heavily on the assistance of others can be seen as a burden to a company rather than an asset. In the CADT program's project-based courses, students are typically free to assist each other as they work on their assignments. Indeed, many of the projects are team-based where students are required to work with each other. Team work is an important skill, but if a student never makes the leap to be able work independently, then his or her value to a future employer will be limited.

Related to the ability to work independently is being able to work diligently. Completing tasks within a reasonable amount of time is a requirement for an effective technician. The job market is competitive, and if students are unable to accomplish their work productively, they will be at

a distinct disadvantage. Thus, time management and speed are an important part of the assessment process.

A formal means of assessment is very valuable in determining the students' true independent skills. Furthermore, relying on a final exam for this information may not be enough, because it would be too late to address the students' weaknesses during the course. Ideally, a series of formative assessments should be given to the students throughout the course. This would provide the instructor with important information about the student's independent skill development and allow for adjustments to provide students with more independent practice. Ultimately, the instructor has the task of preparing students for a successful career. Part of this responsibility is to accurately assess the students' progress towards this goal, and to make adjustments as needed. Even though a course may be project-based, providing formal means of assessing students' independent skills remains a critical part of the educational process and should not be dismissed as unnecessary or too burdensome.

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