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Adapting PBL Instantiation to Promote Students' Engagement

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Abstract

PBL has been instantiated in different ways in each university. Authors like Savin-Baden, Kolmos and Andersen propose models and principles that help to understand the key aspects of PBL in general and of our PBL instantiations in particular. The goal of this study is to understand our PBL instantiations and establish a framework to help our faculty members to design PBL. As an experience, we have used this framework to promote students' engagement. This has been done tuning participant or student direction principle. We have made two experiences with the same students in two consecutive semesters of the 2nd year of Computer Science degree and Telecommunication degree of Mondragon University. In the first experience, the problem has been defined by teachers and in the second one by students. In order to measure the consequences in terms students' engagement, we carried out a questionnaire. Additionally, we have also measured deep learning using students approach to learning with Dolmans' PBL-R-SPQ questionnaire. In those experiences, we have observed that the students' engagement and the classroom climate improved significantly. We have also observed that the students approach to learning didn't change.

Keywords: PBL, Learning approach, PBL principles, Students' engagement;

1. Introduction

The engineering faculty of Mondragon University has established a common educational model for all the diplomas. It is a mixed model, where there are activities related to courses, at the beginning of the semester, and an interdisciplinary PBL at the end of the semester. The PBL can take 30-50% of all the ECTS (European Credit Transfer System) on each semester. Each students group can have a slightly different context where a series of technologies needs to be used in order to solve a problem. All the students need to achieve the predefined learning outcomes (Arana-Arexolaleiba 2011). At the end of the PBL, the students group build complex technological artefacts.

In the last 10 years, we have implemented different type of PBL. In some cases, the solution was known in advance by teachers. In other cases, teachers have only an idea of the solution and the students have freedom to propose his/her solution respecting some constraints (Learning Outcomes, material availability, deadlines,...). We have observed that the students' engagement is different in each type of project.

We have also observed that during those PBL the students focus a great amount of energy in artefacts building, but they tend to use trial and error strategy. We consider that this type of strategy is not suitable for understanding of theoretical concepts. In fact, they show difficulties to support their work from a theoretical point of view. We think that they have not learnt in depth. But what is deep learning? And, what are the main variables that affect deep learning in a PBL framework?

In conclusion, with this study, we aim to understand our PBL instantiation(s). The concept of PBL instantiation was firstly used by Savin-Baden (Savin-Baden 2012), as the process of implementing a PBL with specific characteristics. We would also like to establish a framework to help our faculty members to design PBL. As an experience, in this study, we are going to use this framework to promote students' engagement in a PBL and measure the consequences in terms ofr student's engagement and student approach to learning.

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2. Review of the literature

The fundamental thesis of Illeris (Illeris 2007) is that all learning involves three dimensions: content, incentive and interaction. Those dimensions must always be considered in an understanding of any learning situation.

As Ausubel stresses, "*the most important single factor influencing learning is what the learner already knows*" (Ausubel 1978). Illeris lists 4 types of learning (Illeris 2007): Cumulative, assimilative, accommodative and transformative. The cumulative learning happens when we learn by heart. The assimilative learning happens when the impressions from surroundings are incorporated and linked with the previous knowledge. The accommodative learning happens when there is partial or full restructuring of mental schemes. And the transformative learning is like a catharsis, bigger than the previous accommodative learning.

Biggs (Biggs 2007) classifies students approach to learning in two types: deep and surface:

1. Surface learning approach: the motivation is just to carry out the task. The student tries to identify important items to pass the exam and just memorizes them.

2. Deep learning approach: is driven by internal motivation (or intrinsic motivation) and curiosity. There is a personal commitment to learning. New mental structures are built. If a student has success in a given task, his intrinsic motivation increases.

Biggs propose R-SPQ-2F (Revised Two Factor Study Process Questionnaire) (Biggs 2001) to measure students approach to learning. Dolmans (Dolmans 2010) has adapted this questionnaire to PBL context (PBL-R-SPQ questionnaire). In this study we have used Dolmans' questionnaire.

Biggs (Biggs 2007) also proposes SOLO taxonomy (Structural Observable Learning Outcomes). It has 5 levels. Each level represents a different rearrangement of mental schemes. Whenever more mental schemes are restructured, more relations are made among the concepts, and in consequence, deeper learning is achieved. We can say that students achieve deep learning if they achieve levels 4 & 5 (qualitative phase) of SOLO taxonomy. Unfortunately, during this study we were not allowed to adapt our PBL learning outcomes to SOLO taxonomy.

Some authors (Kolmos 2009) (Andersen 2002) claim that PBL has learning principles. On the one hand, Kolmos (Kolmos 2009) proposes 9 principles that can be captured in three approaches: Contents (Interdisciplinary, exemplary, theory and practice including research methodologies), cognitive learning (Problem, project, experience and context) and collaborative learning (Teams and participant directed). On the other hand, Andersen (Andersen 2002) suggests that PBL has four principles: Problem orientation, student direction, exemplarity and inter or trans-disciplinarity. As we can observe, both models share some of the principles.

Kolmos' model adds the "*approach*" layer. This layer helps us to find similarities with Illeris triangle. Content approach (interdisciplinary, exemplarity and theory-practice) is linked with the content dimension of Illeris (knowledge, skills and attitude). In addition, Kolmos' collaborative learning approach is about teamwork and participant direction, this approach is linked with Illeris's interaction dimension. Finally, cognitive learning approach is a specificity of PBL comparing with other teaching learning activities.

In our case, some of those PBL principles were difficult to change or we were not allowed (i.e. learning outcomes). In this study, we have focused our energy in participant or student direction principle. Reinforcing student direction involving them in problem definition, we expect to increase students' engagement. As it is quoted in (Bigge 2004), "*Once a person has chosen a goal, the person will behave in a manner intended to achieve that goal*". Bigge & Shermis stress that (Bigge 2004) "*For a 'problem' to be a problem a person not only needs to feel a tension in a situation but also needs to have some idea of the nature and cause of the tension*." We would also like to obsever if there is any change in student approach to learning.

As we can see in figure 1 there are two PBL processes. The process shown in figure 1 (a) is teacher or system directed and the figure 1 (b) student directed process. In the figure 1 (a), students are only responsible of the analysis and development of PBL. In the figure 1 (b), students are responsible of the problem definition and can also be co-responsible of the evaluation.

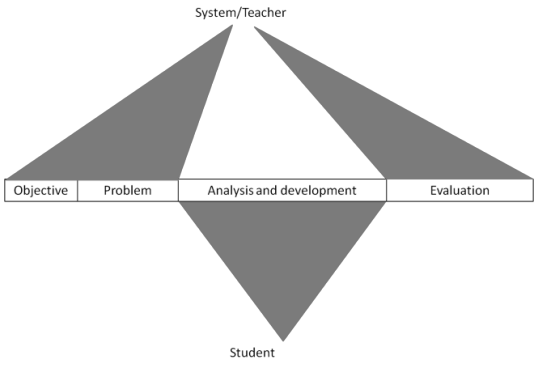

Figure 1. (a) Teacher directed process

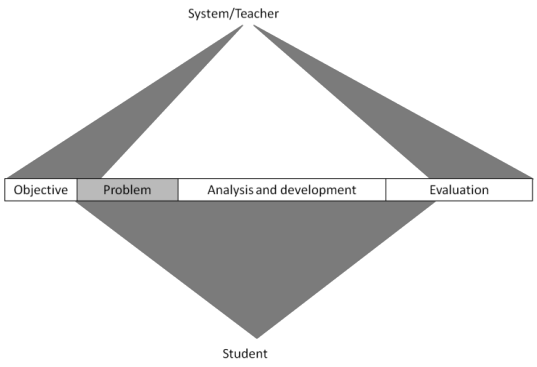

Figure 2. (b) Student directed process

Summarising, firstly, in order to increase students' engagement, we are going to instantiate a more student directed PBL,

allowing them to define the problem they are going to deal with. Secondly, we are going to measure students' engagement with a PBL. And finally, in order to measure student approach to learning (deep/surface) we are going to use Dolmans' PBL-R-SPQ questionnaire.

3. Methodology and implementation

This experience was made in the 3rd and 4th semesters' PBL of Computer Science degree and Telecommunication degree (See figure 2). In both semesters, there is a 6 weeks long PBL. In the 3rd semester the problem was defined by the teacher team. Student groups were allowed to select among the predefined problems in a first come first serve basis. In the 4th semester, the problem was defined by the students themselves.

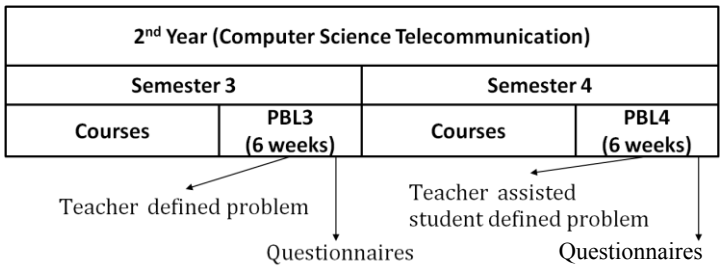

Figure 2. 3rd and 4th semesters implementation structure

At the beginning of the 4th semester (see figure 3), we had explained to students that they were allowed to define their problem, based on established learning outcomes. Students started thinking about the problem and sharing their ideas with the supervisors. At the end of the 9th week, student groups had submitted their proposals. Those proposals were validated by the supervisors.

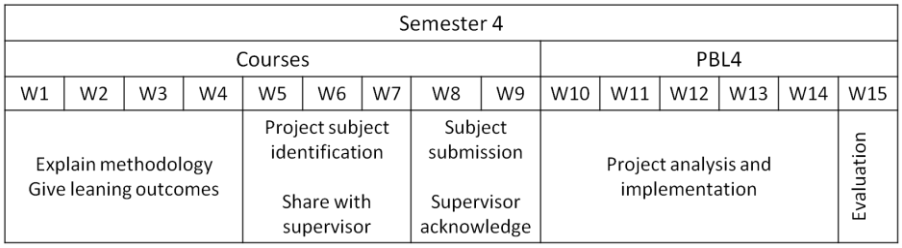

Figure 3. 4th semester problem definition and project implementation planning

During the 14th week of each semester (3rd and 4th) students were asked to fill out an "*ad-hoc*" questionnaire and Dolmans' PBL-R-SPQ questionnaire (Dolmans 2010). In the first questionnaire the items are rated also on a 1-5 scale (1=yes, I am agree with the statement, 5 not, I am not agree with the statement). Those questions were developed among three teachers from three different universities. In the PBL-R-SPQ questionnaire the items are rated on a 1-5 scale (1 = never or rarely, 2 = sometimes, 3 = half of the time, 4 = frequently and 5= always or almost always). The outcome of 17-items allows the researcher to determine student approach to learning: there is 8-item for deep learning approach and 9-item for surface learning approach.

In total 19 students (3rd semester – PBL3) and 18 students (4th semester –PBL4) filled out the questionnaire, giving a response rate of 67.8% in PBL3 and 64.2% in PBL4. The average age of students when entering the programme was about 19 years and most (about 71.4%) of the students were male. The study was conducted using a web tools and respecting the anonymity of students' responses.

4. Results and discussion

There were 7 student groups, each one with 4-5 students. 6 student groups (out of 7) proposed their own project subject and one team proposed 7 project subjects.

As we can see in the next table students items related with students' engagement were already positive in the PBL3. Most of the items are lower than 2.5. But all those items have significantly improved in the PBL4. The results agree teacher opinion.

Table 1. Students' engagement

	PBL3 (19/28)		*PBL4 (18/28)*		*Std mean Dif*
	Mean	*SD*	*Mean*	*SD*	*Cohen's d*

I have participated in a lot of discussions	2.94	0.66	2.25	1.00	0.85
I have felt very confident in the decisions/conclusions throughout the course	2.35	1.00	2.00	0.97	0.37
We really liked the problem we were assigned	2.00	0.94	1.38	0.62	0.81
We have always believed the problem was affordable for us and we were going to succeed	1.88	0.99	1.63	0.96	0.27

In this study, we have also measured other items (see table 2) linked with the classroom atmosphere. As we can see in the table 3, both items has changed improved significantly (Cohen's d 2.68 and 2.04). Those results also agree teacher opinion.

Table 2. Classroom atmosphere

	PBL3 (19/28)		***PBL4 (18/28)***		***Std mean Dif***
	Mean	***SD***	***Mean***	***SD***	***Cohen's d***
The atmosphere of the classroom has given me the freedom to use my own judgment	3.82	1.01	1.63	0.62	2.68
I have been able to make my own decisions	3.06	1.03	1.44	0.51	2.04

Finally, we have measured students approach to learning using Dolmans' questionnaire. As we can see in the next table in both PBLs students reported deep learning approach PBL3 (M=3.161, SD=1.16) and PBL4 (M=3.14, SD=1.17). On the other hand, the absolute value of standardized mean difference (Cohen's d) between both PBLs is lower than 0.049 (see Table 1); this means that statistically we cannot consider as a significant change.

The standard deviation in both approaches was quite high, if we compare with other references like (Dolmans 2010). There could be several reasons: different learning experience in the semester, different pedagogical background of the supervisors, different type and level of the learning outcomes or different assessment experiences among others.

Table 3. Computer Science and Telecommunication degree

	PBL3 (19/28)		***PBL4 (18/28)***		***Std mean Dif***
	Mean	***SD***	***Mean***	***SD***	***(Cohen's d)***
Deep learning approach	3.161	1.16	3.145	1.17	0.014
Surface learning approach	2.254	1.1	2.308	1.13	-0.049

5. Conclusion and future studies

This study has helped us to have a better understanding of the key aspects of PBL in general. PBL principle models have been helpful to have a wider view of PBL "*world*". These models also give us principles that can be tuned in order to adapt PBL methodology and create a particular instantiation. In this study, we have used to increase students' engagement tuning participant direction principle. This model has also been useful to share among staff members (old and newcomer) participating in those PBLs our particular instantiation characteristics.

From a practical point of view, with those models we have increased significantly students' engagement and the classroom atmosphere. The students were not only active but they also acquired the project ownership. They had a freedom to design their own solution. The numerical results and the teacher opinion agree. Anyway, a more reliable questionnaire needs to be developed in order to have statistically significant results.

We think that the students' engagement can be increased. If we see the figure 1 in this study we have only involved students in the problem definition, but we can also involve them in the evaluation process. For example, we can involve them in the definition of the evaluation criteria and self-evaluation and/or co-evaluation process of some of the learning outcomes.

The students, in both PBLs, have adopted deep approach to learning. Only reinforcing students' direction has not push student to adopt deeper approach. There is no significant change among both PBLs. As Gibbs (Gibbs, 2003) suggests, assessment can support the learning process. As Dolmans stresses, the "*Perceptions of inappropriate assessment may move students towards a surface approach*" (Dolmans 2010). The lack of deep learning outcomes and misalignment (Biggs 2007) between learning outcomes, assessment and PBL could be one of the reasons why in both PBL instantiations the student approach to learning is similar.

Finally deep learning can also be reinforced avoiding trial and error methodology. This method, naturaly used by the students, can be enriched by reflection and conceptualization phases of Kolb cycle. This process need to be facilitated by supervisors.

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References

Andersen, O.D. and V. Larsen. (2002). *Problembaseret Læring*, FoU-projekt nr. 2000-2734-91, DEL.

Arana-Arexolaleiba, N., Aldekoa-Anton, G. & Markiegi-Gonzalez, U. (2011), *Development of feedback process for competence based program*, Pbl Across The Diciplines:Research Into Best Practice, eds. J. Davies, Erik de Graaff & A. Kolmos, Aalborg University Press, Aalborg, pp. 502.

Ausubel, D.P., Novak, J.D. & Hanesian, H. 1978, *Educational psychology: a cognitive view*, Holt, Rinehart and Winston.

Bigge, Morris L. & Shermis, Samuel S. (2004) *Learning Theories for Teachers*, sixth edition, Pearson.

Biggs, J. & Tang, C. (2007), *Teaching for Quality Learning at University*, 3rd edn, Open University Press.

Biggs, J., Kember, D. & Leung, D.Y.P. (2001), *The revised two-factor Study Process Questionnaire: R-SPQ-2F*, British Journal of Educational Psychology, vol. 71, no. 1, pp. 133-149.

Dolmans, D.H., Wolfhagen, I.H. & Ginns, P. 2010, *Measuring approaches to learning in a problem based learning context*, Int J Med Educ, vol. 1, pp. 55-60.

Gibbs, G. (2003). How assessment influences student learning. If Reform of University Science Education is the Answer - what were the Questions?, Proceedings from the 3rd, DCN Conference,

Illeris, K. (2007), *How We Learn: Learning and non-learning in school and beyond*, Taylor \& Francis.

Kolb, D. (1984), *Experiential learning: experience as the source of learning and development*, Prentice-Hall.

Kolmos, A., Erik De Graaff & Xiangyun Du (2009), *Diversity of PBL – PBL Learning Principles And Models* In Research on PBL Practice in Engineering Education, eds. Xiangyun Du, Erik de Graaff & A. Kolmos, Sense Publishers, pp. 9-21.

Lizzio, A., Wilson, K. & Simons, R. 2002, *University students' perceptions of the learning environment and academic outcomes: implications for theory and practice*, vol. 27, no. 1, pp. 27-52.

Savin-Baden, M. (2012) *Piracy and Problem-based Learning: On Stranger Tides* Keynote presentation at International Conference on Problem- Based Learning 12-13 April 2012, Rovaniemi, Finland Competence and Problem-Based Learning - Experience, Learning and Future