A Narrative perspective to students' experiences in problem-based learning in theory of computation – New deals with learning

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Abstract

In this paper we shall see the problem-based learning in the context of theoretical computer science course, from the students' point of view. We shall consider how the students experienced the new way of learning and reflected the things learnt in their learning diaries and how they adjusted to the process in general. How to make learning more meaningful for everyone. Aim is also to raise discussion about the methods in interpretation and analyzing.

1 Introduction

In this paper we shall shortly present the experiences and feelings of the students in a problem-based course on theory of computation (TFCS) in Department of Computer Science, University of Joensuu. The detailed description of the course can be found in Hämäläinen (4). In this paper the emphasis is on how the students evaluated their own learning, experienced things and adjusted to this new system. We shall partly reflect the extracts taken from students' learning diaries against "Dimensions of Learner Experience"-framework by Savin-Baden (7). As Savin-Baden (7, 6) says: *"The consideration of personal experience in learning is something that is noticeably lacking in general, and especially in PBL, yet for many, personal experience is that which makes learning both possible and meaningful"*. That is also what we are hunting for.

We shall define the problem-based learning and the background of the study in chapter 2. Next, in chapter 3, we shall get to know the framework of Dimensions of Learner Experience: its structure and the means to make transitions within it. We shall get acquainted with the disjunction and the ways to encounter it. The importance of enabling disjunctions as well as the contribution of group-work to the learning will also be discussed. Finally, in chapter 4, we shall have a look at the selected diary-clips to create an overview of the students' learning experience.

2 Methods and background

2.1 Problem-based learning

Problem-based learning (PBL) is a learning method first introduced by McMaster University in 1960's, as a demand for applying the learnt knowledge to real life situations – to meet the world and its challenges (6). In PBL students are provided with practical problems that induce the learning. It consists of learning in small groups, emphasizes how to learn now and in the future, how to end up with solutions rather than getting them 'ready-made', how to develop critical thinking and how to learn to learn. It is a process of continuous concept defining – problem presentation – discussion – self studying – reviewing – evaluation, a play of actions, goals and results with individual learners guided by external facilitator (i.e. teacher) and supporting team (group-work, discussions, brainstorming). (1; 2)

Torp and Sage (8) point out the importance of the concept of "Learning to learn and understand", as well as retrieving information (and thus to get to know how to cope with the "information overload" of today's society). It is also notable that by PBL students can

develop new abilities to be self-directed learners and learn the methods of scientific research, i.e. finding information, proposing and testing hypotheses and presenting results. These higher-order thinking skills (analysis, synthesis and evaluation) are not learnt through direct instruction. They emerge from experience of doing things by yourself and PBL can offer one way to develop these learner abilities (8, 104).

2.2 Learning diaries analysis and research methods

During the course students were asked to write *learning diaries*. They were part of the process and one target of evaluation. In the diaries students wrote about their experiences, thoughts and feelings and analyzed their own learning process. Students could freely express themselves in their diaries and they received comments and feedback weekly.

The selected parts of learning diaries have been further analyzed. No specific qualitative method has been used and the focus is to provide interesting and general descriptions and thoughts emerged during the course, especially at the beginning and at the end of TFCS. The author's aim was to find out the general readjustment to this new way of learning.

3 The framework

The Dimensions of Learner Experience (DLE) is a framework created by Savin-Baden, who constructed it through the stories of the students undergone the PBL-method (7, 54–67). Essential is that students should learn how to deal with their conflicting real experiences and the imagined pictures they possess about learning, i.e. to bring themselves into the learning. Literally speaking students are not learning for the school but for the life, the life which they construct by themselves, creating their own culture of knowledge based on their dynamic epistemological view.

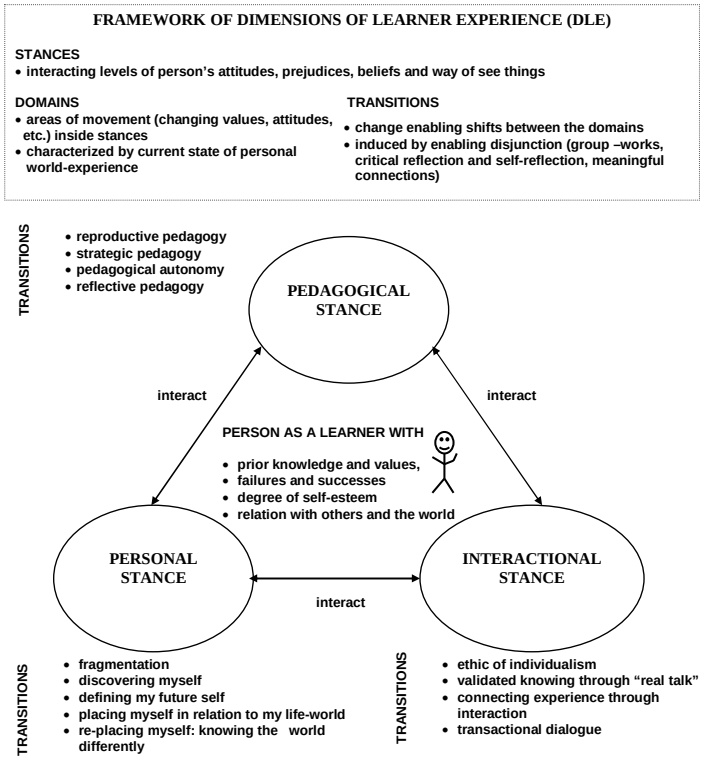

Figure 1: Dimensions of Learner Experience

DLE contains three different, but intertwined, levels/points of view, which Savin-Baden calls for stances. *A stance* is a kind of an extended version of attitude, which covers the sense

of one's attitudes and beliefs towards a particular thing (e.g. context, person, experience) as well as our unconscious prejudices, prior learning experiences etc. A Stance can be further divided into *domains*, which are the particular overlapping areas between which the learner travels, gradually constructing her/his stance by means of transitions. *Transitions* are the shifts in one's learner experience and are strongly connected with the concept of disjunction (7, 100–109). The term *disjunction* means the sense of fragmentation that a student feels in her/his world (of ideas and cognition). It usually involves frustration, confusion and the loss of sense of self and can be either enabling or disabling by nature (7, 89). The structure of the DLE-framework is presented in figure 1.

Next we shall have a closer look at the stances, the hierarchy of the experience world of the student and the issues concerning about the change-points and the sub-structure of different stances. We shall also define the disjunction and how to approach it. We shall reflect the extracts taken from students' diaries in TFCS-course against the framework as examples.

3.1 Stances

The stances are strongly intertwined to each other, i.e. one's personal attitudes and cultural background affect the position she/he may take in an interactional stance, e.g. in a group-work.

The term *personal stance* is used to describe how students and teachers see, define and place themselves in PBL environment (7, 58). It is a playground where experiences are created and one can search one's place in it – it is a particular view of the world at certain point of their "learning career". The personal stance is very transient and induced e.g. by the self perception of students and learning context (which both are changing objects).

E.g. "Defining my future self" can be read on the pages of some diaries:

"I loved the logic of those regular expressions in Problem 3. They are very useful in developing you logical reasoning. It was good for me to learn those logical expressions considering my future profession as a teacher. I will definitely teach these skills also to my students."

"... I abuse the course so that the theoretical foundations do not interest me in general, but it provides me better understanding to things and thus I can make my work [as a professional] better."

A pedagogical stance is the dimension how students see themselves as learners. This is affected by prior learning experiences, some taken-for-granted notions of learning and teaching and the instruction they have received. The domains of this stance represent approaches to learning, the kinds of strategies students have. These are: *reproductive pedagogy* ("traditional", learning as safe and predictable happening), *strategic pedagogy* ("maximize the profit" and choose the methods according to it), *pedagogic autonomy* ("what and how", choosing the methods that satisfy one's own, personally defined needs) and *reflective pedagogy* ("flexible", critical evaluating and deep engaging of the things). (7, 61–63)

An interactional stance brings the relationships into the picture. Its domains are specified according to the nuances of relationships between teacher-student, student-student and student-group (7, 63–66).

3.2 Disjunction

The meaning and purpose of disjunction is gradually to bring towards deeper understanding of the world and the self. Effective "disjunction-management" can provide transitions into students' lives and thus make re-valuing of knowledge and values to emerge – you can call it deeper learning. According to Savin-Baden (7, 89) there are two types of disjunction, *enabling* and *disabling*, and both of them can produce a shift in one's life. The main point is to learn to deal with these disjunctions. Savin-Baden has introduced four different approaches to face the disjunctions (7, 96–98). She reminds that they are just generalized ways to handle a situation,

since conflicts, ambiguity and quarrelling facts experienced by each individual student vary a lot, so do the methods used to overcome them.

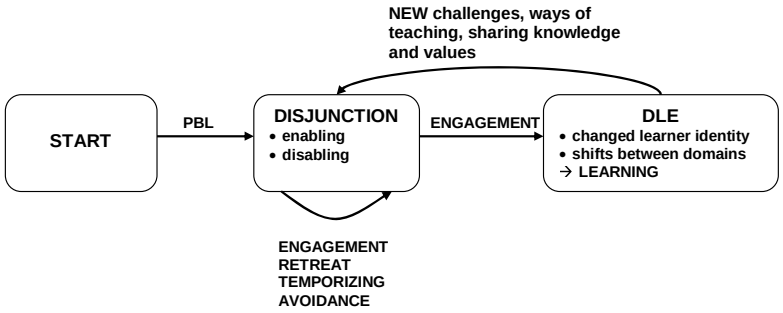

Figure 2: The centrality of disjunction in learning framework (7)

The importance of the disjunction in a learning experience and the ways of coping with it are presented in figure 2. The PBL itself acts as an initiator for disjunction by its novel methods, partly stimulating, partly irritating the learner. Later these same values serve as feedback enabling the life-long learning to occur. Next we shall discuss the ways to handle these irritating and confusing moments.

3.3 Four ways to meet the disjunction

Savin-Baden (7, 96–98) describes four means to attack the disjunction. We shall give an overview of these ways of "lockworkship".

The student may **retreat** the situation e.g. by means of excuses, or building a safe-wall against the threats it seems to pose for their learner-identity. This may worse the situation and thus often causes a disabling experience and heavy tendency e.g. for blaming others or the system used for her/his incapabilities and/or demand for right answers.

This could be well noticed during the TFCS-course, too. Especially for some foreign students it was very difficult to adapt into this new independent method of learning, partly because of the lectures, which were given only in Finnish. Here are some good examples of retreating the situation by demanding answers and blaming others:

"We are going somewhere deeper and deeper to the theory of computer science with nothing provided to read, with nothing provided from where to get the really required information. And more and more time is spent to find it, somewhere outside the course page, somewhere outside the lecture notes ... I think it would be useful if the lecturer mentioned every time the exact place where to get the required material for completing the problems. Especially for foreign students, most of which have to participate in this course."

" ... Please, tell me, maybe am I so clear understand the main goal of our Problems, and maybe must I read somewhere the instructions how to do them and do not going to consider my own ideas?"

This is where the facilitators/tutors enter the picture and try to unlock the situation, e.g. by appreciating the knowledge the student possess and trying to offer assistance in searching for the material, and this is the point where discussions are needed.

The student may **temporize** the disjunction situation. Temporizing means postponing the situation. Students recognize that something needs to be done in order to effective results to take place, but they are not ready to take the transition. The tight schedule and "sticking into one's habits" could also be counted into this category. They inhibit successful transition and thus new ways of seeing the situation and the most effective learning to take place.

Using the **avoidance** the student both temporize and adopt some mechanism to circle the disjunction. She/he finds a way to bypass the situation but this may still be more effort-taking than engaging the situation, because the student cannot escape the situation and it confronts her/him gradually and can make learning an unpleasant phenomenon for her/him.

In order to proceed, the difficulties need to be identified and **engagement** has to enter the picture. It requires to become aware of the existence and roots (internal and external) of the difficulties through reflection. This enables transition to take place (intra or inter domain) and the puzzle to get a bit clearer — until the next disjunction fight emerges. The key point is taking responsibility of one's own learning, which is also one of the fundamental issues in problem-based learning.

Traditional teaching method and its collision with PBL naturally causes a disjunction and starts a cycle. Students begin to view things differently and some type of questioning occurs, like:

"I totally couldn't understand what was the reason to begin the course with solving so called problems, just some spontaneous situations not connected to anything in common ..."

"At the beginning my goal was just to pass the course. When I noticed this new teaching method I jumped to the roof. And when teaching went on, I realized that I do have a capability to learn something, and so it turned out to be at the end, that those previously totally unknown and 'all Greek to me' sounded things like Turing machines, automata, regular languages, context-free grammars, etc. have been cleared up to me. Also getting to know them and using them is not as scary thing than earlier."

3.4 Enabling disjunctions

By providing meaningful examples and new ways of doing and seeing things these disjunction situations can be made easier and more flexible to cause the action of learning – both the subject and yourself. E.g. Ellis et al. (3) have focused the importance of the meaningful problems as motivating actors in PBL. Realizing the fact that her/his prior knowledge and experiences are valued usually acts as a trigger of engagement and starts a journey in the world of different stances of Learner Experience, where the student finds new doors opening and part-time harmony within her/himself. The journey from disjunction to disjunction has just began, taking a form of challenging formula of recursion with ever increasing variables and lots of possibilities.

We shall also discuss the group-work as an enabling factor for creating transitions and how this was experienced by the students of TFCS -course.

"I have once again noticed that this theoretical subject can be approached interestingly, this week with forms of pictures, animations and a game."

"I enjoyed the Art Exhibition. I saw a lot of amusing things. ...I think that an Art Exhibition is a very nice way of teaching, as students do their best at creating pieces of art and share their ideas at the exhibition ..."

And some personal interest to the things:

"Woh!!! I like automata! It's so interesting to me! And I even know why – when my mammy wrote her diploma her theme was 'Finite non-deterministic automata ...', of course there was more mathematics and I think more theoretical things, but the interest is in our blood!"

More creative styles of handling the theoretical issues, e.g. in the form of the poems (generated by the simple automata made by students) can be seen on the Internet.[1]

3.5 Group-work

A group work can function both as an enabling or a disabling factor in the machinery of DLE. Group-dynamics is a difficult issue and e.g. McCracken and Waters (5) have presented that these skills must be taught explicitly to the students. Just working in a group does not facilitate that team-work is learnt.

[1] `http://www.cs.joensuu.fi/~akautone/poems.html`

The use of a group work and the possibilities it offers in PBL were seen mainly as a positive thing in TFCS. It offered many students a new sense of themselves both as giver and receiver of information. It gave them a surface to reflect to and from and get a deeper picture in the problems solved and increased the sense of integrity. Group work as its best is sharing yourself with others and discovering the new waters of the ocean of the knowledge together. Mutual respect is valuable in learning and for learners.

This kind of co-operation and interactional stance is considered fruitful also in the "Real talk" domain by Savin-Baden (7, 65). The following extracts from the learning diaries describe the situation:

"We have solved the problems, as well as demos via Messanger between the members of our team. My friends (and the members of our group) deserve the biggest thanks for the fact that I have managed the course so far, we have supported one another along the journey and helped each other."

"At this phase the benefits in group work started to get concrete. When you have to explain the half you understand to your friends, you usually have to find out the rest of it, too, when someone is asking the classical 'why'-question ... Because lectures are given in Finnish, the things in this course may not be that hard after all, and it's amazing what you can find in the secret closets of your memory ..."

Of course the student takes her/his own position in the field of interactional stance and relates its importance and usage for her/his point of view: what may be gained or lost and in what sense. And it is nice to observe things, too:

"Observing others in different situations is interesting. If you have strengths to listen and observe, you may in some point learn to even understand something."

The concept of group-dynamics play here an essential role, too. It is a challenge. There were also some shifts to be seen during the course from a grouper to an individual and also the other way around.

4 Some more insights into learning experience

Clear and easy classification according to the clips taken from students' learning diaries is quite complex, but it is easy to see the change in their values and reflections on what they know and how they see themselves as learners. Next we shall have a look at some selected diary-extracts.

Finding the appropriate strategy

"At first it took some time to get used to the working method. I think it's also the reason why the first reports didn't cover all. I simply didn't know how thoroughly you should write in them."

"It was nice to notice that I realized how these things have to be studied, because my points from the problems were great after couple of first problems."

" It seems that this course is ok after all. Getting the things clear comes about two weeks late, but it comes after all – actually this is nice way to learn, even if it takes nerves when you have used to lecture based mode. ... In fact this course is getting better towards the end, works are getting along smoothly when you have got the idea what to do and how."

Evaluation of own learning (at the end)

"Science is not my strength, so I want to study it. ... Afterwards the most rewarding courses have been just these hard courses, after which you are no longer the same person than before them. ... I have learned, but there seems to be longer and longer way to Knowing. The course gave me answers, but now I have once again new questions ..."

"I have learned about the content of the course more than I expected. And, if some thing was a bit unclear at this point, I can at least start searching for information in right directions. Finding relevant information may be the most important area of learning in the university, when you can't possible remember everything by heart. ... The problems forced you to study and learn without planning how to do it separately."

"After all I was surprised by the fact, that I could get the ideas, and get them well. When I compare the situation to the last year, when I couldn't learn these things in any way."

And creating a "big picture" was important for quite many students:

" How all I have studied so far and in the future really connects with anything? Engaging with separate problems has taken all the attention away from the 'big picture' ... If you could see the 'big picture' it would boost the studying and help finding the essential things."

The same student continues later:

"The problem-game played on last lectures was a good idea. It was good for recap and even cleared the things. I am always in a habit of loosing the 'big picture' and now it was there – on the table in front of me."

"The things covered in the course appeared scattered at first, you couldn't get a grip of the things at hand, but towards the end all started to get clearer. ... it's very pleasant to learn, even if it tooks place so late stage of the course."

"When our course was only started I often asked myself why we study this or that, and why not something else. Now I can think that all we have learnt can be included into this course, because I can find a transition between our themes and computer science."

"Liking and disliking"

Almost everybody liked the PBL-method and some mentioned it to be suitable for themselves, e.g.

"PBL suited me excellently. This was my first trial using it, and I just noticed it to be 'my case'. Things that I tried desperately learn last year on this same course using 'ordinary' method, finally opened to me thanks to the problems. I'd love to take other courses in problem based way, too." ... but some had put it this way:

"The course was very unusual in terms of both teaching and requirements ... I'm not sure if I'll ever take a risk to participate in the similarly based course ..."

This was the conflict where traditional way of learning (getting both information and the instructions how to work from the teacher) was hard to abandon by the student and the ways to treat the situation did not provide the best possible solutions. Also the lack of group-work was a drawback, but the course was passed.

The most remarkable point of disjunction seemed to be at the beginning of the course (as mentioned earlier), when traditional method met the PBL and confusion about the new ways of studying, searching the information by yourself and creating a strategy to cope with the course.

Even those who first took very protective attitude against the new way of learning and who could not deal with the arising disjunctions in an enabling way, were adjusting to the way towards the end of the course or finding the meaning.

"At first I couldn't make any specific goals, because the purpose of the things had not cleared, yet. E.g. in programming the goal is clear, but the plain word 'theory' makes the hair rise up."

"I begin, to my horror, gradually to get warmer to this kind of course, I mean problem based learning. Now when there's no exam in the course, you can better concentrate on what you find interesting and what is of more use and the things that don't interest me can be left with lesser observation, because you don't have to be scared of what the examiner might come up to ask."

Hard but fun under the caring eye of the cognitive coach [2]

All agreed that PBL -method was harder than the traditional, but regardless of that the results achieved usually were considered worth that.

"During the spring I have been obliged to say, that this course has been the hardest one among the courses thus far in the university. Usually it's enough that you just read a little bit the night before the exam and visit few exercise classes. Now when you have decided to do these problem-reports, you have something real to do for every week. On the other hand, learning seems to be a bit more efficient in this way ..."

"The course has been extremely giving, but very hard! I have also found a learning-diary writer in me! This counts for learning, too, I suppose. Previously I used to hate learning diaries, as mentioned in week 1."

And the teacher does make a difference:

"It's very rarely when lecturers are so interested and worrying about studying process. I think W and R are devoting the huge amount of time to the course. It is laudable. And of course it is the reason of our problems, but it's real life."

5 Conclusions

The students found the PBL-course mainly a very positive experience. It was hard but fun, and many achieved a result they never could have imagined to gain. The students also grew to adjust to the new situation and some new deals with learning were committed by them. The study itself serves as a stepping-stone towards further and deeper research in the area and encourages the educators to try and to adopt the PBL in their teaching – in some form.

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