Being a PBL Teacher in Computer Engineering: An Interpretative Phenomenological Analysis

Cristiano da Silva Cintra
UFBA–UEFS Computer Science Master’s Program
UFBA – Federal University of Bahia
Av. Adhemar de Barros, s/n, Ondina
Salvador, Bahia, Brazil, 40170–110
Email: jcanalise@yahoo.com.br

Roberto Almeida Bittencourt
UEFS – State University of Feira de Santana
Av. Transnordestina, s/n, Novo Horizonte
Feira de Santana, Bahia, Brazil, 44036–900
Email: roberto@uefs.br

Abstract—Problem-based learning (PBL) is a well-known active learning approach, and it is becoming increasingly popular in computing. The Computer Engineering undergraduate program at UEFS adopts PBL since 2003. Previous studies thoroughly describe PBL course design and practices, but there is a lack of reports about the teaching experience, i.e., how faculty live the process of teaching PBL courses. Thus, we took advantage of this PBL experience to uncover such issues. We developed an interpretative phenomenological analysis (IPA) to learn the essences of being a PBL teacher, using a qualitative research methodology. Data collection and analysis entailed semi-structured interviews with five UEFS computer engineering professors, interview transcription and memo writing, open coding, code memo writing, code grouping and abstraction, and description of essences. Results led to the following essences: 1) feedback is essential for student success; 2) PBL develops better students and professionals; 3) assessment is complex and multifaceted; 4) developing good problems is a difficult skill; 5) PBL requires strong teacher engagement and background; 6) it is essential to keep a motivating scenario; and 7) good coordination and group dynamics is required. In this paper, we describe the four first essences in detail.

Keywords—PBL, problem-based learning, teaching, essence, interpretative phenomenological analysis.

I. INTRODUCTION

Problem-based learning (PBL) is a student-centered, active learning approach envisioned by physician Howard Barrows, between the 1960s and 1970s [1]. Briefly, PBL is an instructional method that uses a hypothetical case, i.e., problem, to start, guide and motivate learning. In PBL, students are constantly stimulated to learn and take an active role in their learning construction process [2]. The problem is a central element of the approach, motivating study and integrating knowledge. Problems are usually ill-defined: instead of finding one unique correct solution, students understand the problem, retrieve information, build possible solutions, evaluate options, and present results.

Nowadays, problem-based learning (PBL) is an increasingly popular learning approach, adopted not only in medical education, but also in areas such as nursery, engineering, and science [3]. In computing, PBL experience reports have been thoroughly described both in isolated courses and in integrated curricula [4].

Previous studies in computing education thoroughly describe PBL course design and practices on a range of subjects [4], [5]. However, there is a lack of reports delving into the teaching experience. We are especially concerned with a lack of knowledge on teachers’ feelings and impressions of the PBL experience, i.e., how they understand, live, and feel the process of teaching PBL courses. Thus, we decided to take advantage of the eleven-year PBL teaching experience in our Computer Engineering program at the State University of Feira de Santana (UEFS) to uncover these issues.

To understand feelings and impressions, the research method of phenomenological interpretative analysis (IPA) analyzes how life experiences make sense to people who live them. In our case, we are particularly interested in the meanings that faculty realize when they live the everyday flow of experience with PBL. Building on this research approach, we decided to investigate how faculty members of Computer Engineering at UEFS live the PBL approach in their everyday lives.

More generally, we developed an interpretative phenomenological analysis (IPA) of what it means to be a teacher in a computer engineering program that is strongly based on a PBL approach. To do so, we used a qualitative research methodology based on a contemporary IPA approach [6]. IPA is useful in this context, since it helps to understand the inter-subjective experience of a small group, reducing their multiple accounts into the essences of the phenomenon. Data collection and analysis was based on Smith’s IPA protocol [6].

Results led to the following seven essences: 1) feedback is essential for student success; 2) PBL develops better students and professionals; 3) assessment is complex and multifaceted; 4) developing good problems is a difficult skill; 5) PBL requires strong teacher engagement and background; 6) it is essential to keep a motivating scenario; and 7) good coordination and group dynamics is required. In this paper, for the lack of space needed to describe phenomenological accounts, which are usually deep and thorough, we describe only the four first essences from an IPA standpoint.

This paper is organized as such: Section II provides the background for this work. Section III describes the research methods. Then, Section IV presents our results. Conclusions are derived in Section V together with suggestions for future work.
Problem-based learning (PBL) is an active learning approach conceived between the 1960s and the 1970s in the Faculty of Medicine of McMaster University, Canada [1]. Idealized by the physician Howard Barrows, it has soon gained widespread adoption in other schools of Medicine around the world. Barrows realized the dissatisfaction of students with traditional lecture-based approaches, in a world driven by an explosion of information resources, new technologies, and growing demands on future physicians and their practices. Later, PBL spread to other educational contexts such as science in higher education [2] and elementary education [7].

In PBL, not only are students constantly encouraged to learn, but also to take an active role in the process of learning construction [2]. A problem in PBL is a trigger to motivate study. It usually follows a learning cycle, repeated for the duration of the problem [1], [2]:

1) Students are presented to an ill-defined problem before any preparation or study;
2) Students assemble in groups to organize ideas and recall previous knowledge related to the problem;
3) Through discussion, students pose questions, known as learning issues, that deal with aspects of the problem they do not understand;
4) Learning issues are ranked in order of importance, and students define learning goals for independent and group study;
5) Students reconvene to explore previous learning issues, and integrate new knowledge to the context of the problem.

PBL has been adopted in various computing courses throughout the world. A systematic mapping study has found 52 papers that report experiences of PBL in computing. Courses range from software engineering [8], computer programming, software quality [9], and operating systems [10], among other subjects.

In Brazil, the most well-known PBL experience in Computing has been pursued, since 2003, at the State University of Feira de Santana (UEFS). The Computer Engineering undergraduate program at UEFS adopts an integrated curriculum based on PBL [11], [12]. In this program, PBL is adopted in nine integrated courses with core subjects ranging from programming, digital systems and software engineering, to distributed systems, digital signal processing and programming language design [13]. A wide range of experience reports in courses as different as computer architecture [14] and advanced programming [15] have been published in Brazilian conferences on education in computing or engineering\(^1\). Angelo and Bertoni have organized the results of experience reports in the various courses reports in a survey [13].

PBL is an integral part of the pedagogical project of Computer Engineering at UEFS. It is used in a curricular component named integrated study, which takes between 90 and 180 class hours and entails a mix of tutorial groups, lectures, resource meetings, and lab activities [13]. Different subjects are integrated under the integrated study. For instance, the integrated study of advanced programming joins object-oriented programming, data structures and software design. This structure was implemented in 2003 to reinforce the interaction between theory and practice through a situation–foundation–realization cycle [11].

A tutorial group is formed by a tutor, usually an assistant professor or a teaching assistant that facilitates the learning process, and a group of up to ten students. Two students are initially assigned to work as coordinator and scribe. Sometimes, a whiteboard scribe is also assigned to take notes of group ideas and decisions. Roles are not static, there is usually role rotation between students so that everyone exercises different skills. After receiving the problem, students follow the previously described learning cycle [2], [12].

During the academic term, tutorial groups meet, usually once or twice a week, to perform the activities of a tutorial session. During this session, and following the PBL learning cycle, students read the problem, raise hypotheses and ideas to solve it, describe facts that they know, raise questions about what they do not know, and establish goals for independent study. In the following session, they reconvene to discuss what they have learned, and try to integrate the acquired knowledge to solve the problem. While there are issues still unsolved, students repeat the cycle. The tutor does not provide explanations about the subject. Instead, he or she guides students in their discussion throughout the problem. At UEFS, the PBL learning cycle is explicitly defined by eight steps: starting point, brainstorming, systematizing, question formulation, establishing learning goals, process evaluation, independent study, and follow-up [12].

Student assessment is carried out individually, taking into account both student participation and final product quality, i.e., whether the solution to the problem is appropriate according to established criteria. A final product is usually accompanied by a report. In some cases, after product assessment, tutors may discuss the pros and cons of each student’s solution in a feedback session. Later, students return the revised report for a second round of assessment.

The way tutors assess students is continuous and process-based, usually resorting to various types of assessment instruments: diagnostic assessment, formative assessment, summative assessment, peer assessment and self-assessment [12], [13].

PBL has brought various benefits to Computer Engineering at UEFS: students mature both academic and professionally, they gain experience in managing teams, develop abilities of self-criticism, and learn writing and speaking skills [16].

Together with benefits, new challenges arise: the lack of resources dedicated to teachers of computing courses that adopt PBL; difficulties with student participation, especially free riders; difficulties with interpersonal relations between students; difficulties to ensure full participation of each tutor in problem design; and difficulties with administrative support to the PBL approach and curriculum [16]. Nonetheless, regardless of the challenges, most faculty of Computer Engineering at UEFS are enthusiastic advocates of the PBL approach.

---

\(^1\) See the PBL at UEFS web site: http://www2.uefs.br/pbl/
III. Methodology

Here we describe the theoretical framework we adopted, research design, participants, and procedures for data collection and analysis.

A. Theoretical framework

This research was developed by means of a qualitative research methodology, which is mostly exploratory in nature. Our goal here is to understand the meanings of lived phenomena in human experience. One qualitative research approach that allows reaching this goal is phenomenological research [6]. Phenomenology allows subjective aspects and implicit or even conscious motivations from individuals’ everyday life to emerge in a spontaneous way.

The particular approach of interpretative phenomenological analysis (IPA) and its associated procedures [6] makes it simpler for researchers other than philosophers to reach the essences of a particular lived experience. IPA allows to understand the inter-subjective experience, i.e., how experience lived by some individuals is reduced from their multiple accounts into the essences of the phenomenon. IPA lets the everyday flow of experience lived by individuals be condensed into special meanings to them. In our case, we want to understand what it means to be a PBL teacher in a PBL-based curriculum.

B. Research design

More formally, the main goal of this study was to investigate the essences of the teaching experience for the faculty members of a Computer Engineering undergraduate program that adopts PBL as its main pedagogical approach.

The research questions that guided this study to reach the main goal were:

1) How do faculty understand the planning of PBL courses?
2) How do faculty perceive the assessment of PBL courses?
3) What is the view of faculty about preparing PBL problems/triggers?
4) How do faculty understand their conduction of a PBL tutorial group?
5) How do faculty provide feedback to students?
6) Which perceptions do faculty hold on the advantages and disadvantages of the PBL approach?
7) Which difficulties do faculty experience when they offer PBL courses?

C. Participants

The participants of this research were faculty members of the Computer Engineering undergraduate program at the State University of Feira de Santana (UEFS), located in Feira de Santana, Bahia, Brazil. There were five participants: three female, and two male. Participants had from two to eight years of experience with PBL, experience that begun when UEFS hired them. Most of them had previous experience with other traditional teaching approaches (e.g., lecture-lab combinations). Two of them came from the area of electronics, one from networks and systems, and two from software development.

We believe that this moment is appropriate for data collection, since the PBL approach has been used for eleven years in the institution, and it is now routine in faculty’s lives. After this period, their feelings about the approach are more consolidated, making it more appropriate to collect information, and providing rich testimonials about their lived experiences.

We limited the number of participants by two criteria: first, we used Smith’s IPA protocol of interviewing between five and seven individuals. Phenomenological research requires long and deep interviews, valuing more quality and depth than quantity and breadth; second, after each interview, we asked ourselves whether our questions were sufficiently answered. We ended up with five participants. It is worth noticing that we had two more participants that took part in pilot interviews, but their accounts are not described in the results.

Participants were informed about the purpose of the research, the assurance of confidentiality and anonymity, and their right to participate or not. After these explanations, they agreed to sign an informed consent form. Participants’ speeches were identified with codes, starting with the letter R, and followed by sequential numbers from 1 to 5.

D. Procedures for data collection and analysis

We used semi-structured interviews. This choice was made because they are flexible, but still keep important topics in mind. With semi-structured interviews, participants can freely reflect on a theme, object or concept. They let subjective aspects and motivations, either implicit or explicit, emerge. Furthermore, they are also the main data source in interpretative phenomenological analyses.

We started with an interview guide, which was validated in two pilot interviews with two other faculty with PBL experience. Pilot interviews let researchers check whether interviews have: reliability, which is getting similar results, regardless of who interviews; validity, which is examining whether all the needed data is collected and no important data is left out during collection; and operability, which is verifying whether the vocabulary is accessible and the meaning of each question is clear. After the pilot interviews, we updated the interview guide to improve data collection in the next phase.

We scheduled interviews at UEFS, according to participants’ choices of data, time and place. This let them at ease to answer the questions without external interference. Respondents answered questions freely in a time interval between 55 minutes and 1 hour and 20 minutes. We let respondents spontaneously express their thoughts and experiences, avoiding interrupting them or intervening in their speech.

The process of data collection, transcription, coding and analysis followed a mix of Smith’s protocol and our own experience with qualitative research:

1) Perform interviews (ours lasted between 55min and 1h20min);
2) Write interview memos right after the end of each interview, to collect first impressions;
3) Transcribe interviews;
4) Code the interviews with open coding (which led to 440 initial codes, in our case);
5) Write code memos, to sketch an initial interpretation of lived experience;
6) Abstract codes in a second level, observing relationships between codes and participants’ speeches, and group codes by their common features (at this stage, we found 170 categories);
7) Abstract the essences of lived experience (in our case, seven relevant themes);
8) Report the essences first as draft memos, then as rich accounts after thorough rewriting.

IV. RESULTS

Here we describe the essences of being a PBL teacher in Computer Engineering at UEFS, uncovered by interpretative phenomenological analysis. In short, the essences uncovered were:

- feedback is essential for student success;
- PBL develops better students and professionals;
- assessment is complex and multifaceted;
- developing good problems is a difficult skill;
- PBL requires strong teacher engagement and background;
- it is essential to keep a motivating scenario;
- good coordination and group dynamics is required.

In this section, we thoroughly describe the four first essences, using an IPA reporting approach [6]. We decided to report only four essences mainly for lack of space. The essences presented here were chosen because of their frequency in faculty’s accounts. Qualitative research reports demand accounts that are thorough and deep, and it is sometimes better to report less results in deep than more superficial results [17]. It is worth noticing that the interviews were conducted in Portuguese, while accounts are described here in English.

A. Feedback is essential for student success

Feedback is an important tool in the teaching-learning process. Students accept feedback well, as this contributes to their knowledge acquisition. Teachers use some feedback forms, and the most used are: session feedback, performance feedback, report feedback, problem feedback, group feedback, and individual feedback. The timing for feedback is also crucial. Teachers can feel this timing by observing class evolution.

To Hattie and colleagues, effective feedback must answer three questions posed by teachers and students: Where am I going? (What are the goals?), How am I doing? (Is progress developing toward the goal?), and Where should I go? (What activities should be done to improve progress?) [18].

Feedback is an integral part of the teaching-learning process, which guides students to behave and perform according to given requirements, and lets them know how they are being seen and assessed by teachers. Lack of feedback leaves students lost, not knowing which way to follow. Feedback can be seen as a compass, giving the north to achieve the goals. “I think that feedback is essential[…] for learning. The student that takes advantage of this feedback, he has a possibility to learn much more.” R2: “[…] at each session, it is necessary to give feedback and this is important so that they can evolve. […] from feedback, the student can improve the weak points[…]” R3: “If there was no feedback, it is like the problem has not existed, like no knowledge has been produced here […]” R4: “[…] the feedback, I think, is one of the most important things of any approach […]” R5; “[…] read what you wrote, see if a person that reads this text for the first time knows what you’re talking about, see if she can understand what you say, then I always bring this feedback […]” R1.

Performance feedback is aimed at reorienting or stimulating future behavior. It is also used to maximize the performance of an individual or a group. In the learning environment, feedback is very important because it motivates students to perform their tasks more productively. If a student gets faster feedback on something he or she is doing, accomplishments come earlier. The knowledge acquired by students needs to be consolidated somehow, and this is possible when the tutor situates students, showing where they are hitting or missing.

The feedback that teachers provide gives students a parameter of development. The sooner they are given feedback, suggestions or criticism, the easier students take them more constructively. Generally, students have a good acceptance of feedback provided by the teacher. “[…]the reactions are varied, then, you know, I think, in general, they accept the feedback well. I keep putting myself in their place, I would accept well because I think everything we receive from criticism even being … let’s say negative, it is being part of our development. Then, in general, apparently yes, but I’m not sure…” R5; “I get this feedback from them, and then I later try to analyze what is not going well[…]” R4.

A technique used by teachers is to hand out an assessment form to students. With the form in hand, students perform self-assessment. At the end of the session, the teacher collects the forms, compares them to the performance grade they had given the student, and provides feedback about it, especially when there are discrepancies.

For the teachers, conveying a correct and assertive feedback requires understanding the student who receives it, the way he or she interprets the message, and also adapting it to particular situations. To assist in this task, teachers use some ways to provide feedback: session, performance, report, problem, group, frequent, generic, individual and technical feedback. In any way, the truth is that feedback is essential for students to produce their results and remain motivated. When the teacher takes a stance of not providing feedback, he or she is depriving students of the opportunity to improve their performance. “I have been in sessions where some tutors spend three or four sessions... Ask the students: and then? They say: I don’t know. How is PBL? I don’t know. Because they don’t know, like, if it’s going well, if it’s going bad, if he’s learning something, if he’s not learning anything, because feedback is not given to them...” R2.

At the end of each session, the teacher conveys students the issues to be improved. “[…] session feedback, and then I always prefer doing it at the very end of each session […] depending on the session, that I need to speak another ten minutes at the end of the session, to give that feedback […]
in general, this session feedback. I try not point issues very individually, unless I can do that with everyone. And if I can’t do it with everyone, then I prefer to speak more generally […]” R1; “You give a negative feedback, in the next session they know what they need to improve, then you can give feedback in each session[…] I have a feedback snapshot from each session, in each session I know what was his evolution, and then I take notes of his performance at the end of the session [...]” R3.

Session feedback enables students to realize, in time, which aspects they need to improve for better group dynamics. This is done gradually, in each session.

For performance feedback to work well, people involved in the process need to understand the real meaning of the feedback word, which is positive, an information that serves to evaluate paths and results. Feedback should always be rewarding, never punitive. Whenever punitive, it loses its educational condition and mischaracterizes its function. To apply feedback in its entirety, it is important to note the role of communication in the process, because it is through appropriate communication that feedback information flows. “I have some students, this repeats almost every term, who kind of wait for this feedback, they like to know their performance, because they want to, they try to do something to improve, and they always want to know if I realized that they improved [...]” R1.

Students look forward to receiving feedback: they want to know their learning progress, and which way to go. To make it work, though, it is important to be open to criticism and understand that criticism is focused on improvement, and that feedback is one of the most important steps of performance assessment. Thus, for those who receive feedback, it is important to learn to listen to criticism, as well as to reply to the teacher whenever something was not made clear or was not fully understood.

Reports are a form of assessment that the teacher uses to determine both the student’s writing competence and his or her ownership of ideas in the problem solution. Right after correcting and grading reports, teachers give feedback. Students, then, learn from this feedback. “I give feedback on the report, I prefer that they deliver me the printed report, because then I take notes, I sit with them, ask for their notes, discuss the notes with them, show the weak points, and the same thing for the presentation of the problem [...]” R3.

When the teacher provides feedback, also provides students with a metric of their educational development. Reports are assessed for criteria such as text consistency and cohesion. This enables students to mature their writing.

Providing feedback as fast as possible is important in the teaching-learning process. Students need to have enough time to overcome the difficulties pointed out by teachers. “[...] I tried, if I could not finish the grading, then I would tell them, but I would tell them in the next class, but I think you lose something, the best is when you can finish it in that class […]” R3; “I give feedback at the end of the problem. When the problem ends, I give this feedback.” R2; “I do it as soon as possible, like, the student gave the final solution, at most one or two weeks after that, I give this feedback…” R4. “What I’ve been trying to do, and I do it until the end of the term, is: every session I do session feedback, and I always do it [...]” R1.

It is important to reflect on what students should be told, and to provide concrete arguments when giving feedback. Finally, it is essential that the teacher create room for a frank dialogue and provide the appropriate feedback. That means establishing an environment of trust, discussing the issues, the pros and cons of the student’s performance and products. Ideally, feedback should be given in each session, but this is not always possible, since it demands time. Some teachers give feedback at session beginning, which gives students the opportunity to see where they are missing and focus their efforts on their weak points. Some other teachers prefer to give feedback at the end of the problem or at the end of the term. This timing is useful for the teacher to have a broader view of the student’s profile, to provide feedback with no influence of the student’s behavior in a given session.

B. PBL develops better students and professionals

The PBL approach allows students to develop professional life skills. Skills of written and spoken expression, group management, independent work and learning how to learn: all of them develop a style of entrepreneurship strongly valued by the marketplace, easing the process of graduates adapting to professional life.

Some people develop capabilities of spoken and written expression easily, almost as a gift. Nevertheless, for most people, expression in an adequate professional manner is a constant exercise that involves factors such as role models, environmental stimuli, and, of course, practice. “I clearly realize their resourcefulness to speak, to participate, this influences in class [...] students will also be more prepared to develop further research without forgetting that side, for example, of an oral presentation, got it?” R1. When students take part in a PBL tutorial group, they develop their orality, diction, and cognitive abilities, skills considered relevant in a competitive market.

Student skills are stimulated with PBL dynamics. Students fulfill different roles such as coordinator, scribe or participant. Role changing allows fostering latent skills.

Nowadays, information is present in different forms and sources. In an environment of information overload, knowing how to search, interpret and transform information into knowledge is essential. PBL students search information to autonomously solve problems in various spheres. “[...] I hear of the students who have already graduated, how much they are well regarded in the market for their ability to run after things [...]” R1; “[...] you realize that students... they learn to solve problems or they get better at solving problems [...]” R2; “One of the main advantages is the autonomy to solve problems, I think it shapes a lot the profile of the student who learns through PBL [...]” R4.

Observing the development of those skills in PBL group sessions leave faculty satisfied and professionally accomplished. “Look, I feel motivated because sometimes I am surprised by the ability that a student like this has, for example, when he faces an unknown problem, you know? So, sometimes you think the problem is going to be complex, is going to be difficult at first, but then, in the brainstorming of the first session, students already have some very interesting ideas ...” R2.
Developing a clear, consistent and cohesive prose is a skill better accomplished by stimulating both reading and writing. In PBL, students are encouraged to write most of the time. They constantly write reports at the end of any problem. They deliver their reports to the teacher, who suggests corrections to their written text. Since there is continuous evaluation, students are able to develop or enhance their written expression along the PBL courses. “[...] the first report, it may not do very well, but during the work that is being done, in the last one, his result is already better... I believe there is an evolution in the report writing process.” R3; “Another interesting issue, I do not know if it is in our PBL here, or if it’s related to PBL in general, but the ability to write better...” R4; “[...] we ask for reports, it can be in the student report format, or in a paper format, so, besides the skills of speaking, clearing doubts, researching, learning on his own [...]” R5.

In tutorial sessions, students choose roles to fulfill (or have roles chosen by their tutors) in the group. The role might be of coordinator, scribe, whiteboard scribe, or simply a regular participant. Those roles also influence skill development. “they are encouraged, and in various forms, including grades, to participate in the discussions all the time, to position themselves” R1; “we can already identify students who have the leader profile... you realize with the students that he has more of a leadership profile” R3; “exercises a bit of leadership, since he performs activities as the PBL coordinator” R4.

Learning through an approach that lets them experience some issues they will face in their future jobs helps students to develop skills required in the workplace. “[...] you can see students quietly advancing after they leave university and move to the workplace with no issues. [...]” R4.

Teachers feel that the professional accomplishment of most PBL students is a consequence of the approach. With PBL, students are constantly searching for solutions to the problems that teachers propose, which gives them a glimpse and a feeling of being in the workplace. “With regard to learning, and that I hear of students who have finished our program, how much they are well regarded in the marketplace for their ability to run after solutions [...]” R1; “[...] a student that will develop this resourcefulness, I think then he will be more prepared for the workplace[...]” R2.

Developing a student’s potential depends on the teacher knowing the right moment to speak or to silence. This balance is usually linked to the teacher’s profile and his or her command of the PBL approach. “When I’m guiding the PBL session, I want to extract the maximum potential of each student” R4; “So the goal is that everyone tries to strive as much as possible in solving that problem” R4; “Sometimes he thinks he did nothing, but did something... Try to explore this knowledge to the maximum, so he produces.” R4.

C. Assessment is complex and multifaceted

Assessment is the process teachers use to better understand the level of competencies (knowledge, skills, and attitudes) acquired by students as well as to perceive the effectiveness of the teaching-learning methods and educational activities performed. Thus, the act of assessment, although complex, is essential. PBL teachers feel that, in the approach, assessment is fair and thorough. On the other hand, it involves issues that make it difficult for the teacher.

Assessment in PBL is complex because it involves, among other factors, subjective issues. Each student is different, and those differences influence how the teacher develops competencies. For such reasons, assessment has a high degree of complexity, and should be done carefully. “What? Assessment is easy? Assessing is so difficult [...] the PBL model is well defined, but the assessment, for being individualized, is a lot of work [...]R1: [...] assessment is complicated, it is not so trivial [...]” R4; “[...] the PBL approach, I believe it gives more work than the traditional teaching. If you do the PBL approach as it should be done, it demands more time, but it’s more pleasant, I see you’re really assessing the individual.” R3.

Assessment requires perceptions and sensibility from the teacher that go beyond the classroom. Subjectivity of the assessment makes it a complex task to accomplish. “It is not an easy task [...] because not everyone feels comfortable to be evaluated, [...] is not easy you get to them and say this: you didn’t reach the top. Oh, you didn’t research [...]” R3; “[...] sometimes the student begins very well, then he disappears, then another student gets well, and after a while he disappears as well, then both reappear, then, this way it’s very difficult[...]” R5.

If the tutor participates in excess in the tutorial session, it complicates the assessment process, because one does not know whether the students were able to build knowledge or just superficially reproduced what was conveyed by the teacher. “As I told you, I have given PBL courses several times, and I don’t even feel the tutor I’d like to be, and sometimes I have a little trouble with the issue of assessment.” R1; “Excessive tutor intervention makes it difficult to assess.” R3.

Internal and external factors directly influence student learning. Thus, assessing is not a trivial process. Since assessment is a subjective act, every individual has his or her own way to see, feel, and think things out. Fully capturing those factors, making them concrete, and transferring them to objective criteria is a difficult task to accomplish. “[...] however much we try to monitor development, we can’t be sure that that student built that product alone [...]” R1: “[...] So this subjective assessment is hard, and it there has to be some mechanism to try to validate your thinking [...]” R4; “there’s the performance grade, that we try to give every session, but, of course [...] there is the issue of subjectivity..., of your assessing student performance [...]” R5. [...] it [assessment] is much more complete, [...] it is, say, a continuous evaluation, it is not a one-time assessment as in traditional approaches [...]” R2.

In an educational context, it is essential to stimulate students. One way to do so is building learning activities by means of challenges. The problem, a motivating element, is an essential tool in knowledge construction. We know that the student’s learning capacity depends on his or her maturity. However, it can be stimulated by means of challenges. “There are goals for every tutorial session, and they know they have to meet them to reach the evolution, the conclusion of the product, you follow the whole process.” R3.

Self-assessment is well regarded by students. It aims to
measure whether teacher assessment is balanced with students’ perspectives. “[...]
sometimes you can’t do it in every session, but I try to assess and ask for self-assessment [...]
for they realize from the start where they need to improve [...].” R3;
“[...] I prepare a student assessment form, throughout the term this form is with me, and at the end of the sessions, I give my grade and ask them to self-assess [...].” R4.

Continuous assessment allows for a contextualized, flexible and interactive educational practice. The disadvantage of continuous assessment is its subjectivity. It’s hard to turn the participation (or lack of) in a tutorial session into something tangible. However, students need to learn their strengths and weaknesses.

Assessment in PBL tends to be fairer than in a lecture-based approach. The fact that classes have fewer students positively influences assessment, because the teacher can monitor students more closely. “[...] I feel that it is an assessment a little more fair [...].” R1; “[...] so they do not discuss much when they see what they did, and if you justify, they don’t feel so wrong [...].” R3; “I think that [...] looking at theory and PBL, I think I’m more fair in the PBL grade, because I can get closer to the student, I have more data to assess him, I have his performance [...]”. R4; “[...] class of forty is impossible, there is no way you can do it, you could even try, but you couldn’t be fair in the assessment [...].” In more traditional teaching, classes are generally composed of a large number of students. This prevents the teacher to make an assessment as fair as in teaching with PBL, which has smaller classes”. R5.

Assessment is regarded as one of the most important tools available to teachers to achieve the main goal of the teaching-learning process. In other words, it is important to find ways to assess student learning and offer alternatives for safer student development.

D. Developing good problems is a difficult skill

The problem (or trigger) is the motivating element of PBL approach. However, there are factors that make them hard to develop.

A problem in PBL should be motivating and clear, and should mirror problems found in the marketplace or related to students’ daily life. “[...] you think about various aspects related to problems. First, which knowledge will be required of the student for him to evolve [...].” R4. It is important that the teacher estimate the time to solve the problem and relate it to problem goals and content coverage. “[...] measure time against goals that must be met... don’t give the solution for free, but don’t leave anything too obscure to the point of being awfully unclear, and measure the time for the solution. I think those are the main challenges I see [...].” R1.

The process of developing problems that are motivating and similar to those found in the workplace is a difficult task, even though it is feasible. Teachers usually come together and create situations that subsequently turn into projects or problems, but those problems are not stored in a shared database. “We don’t have a problem database, by the way, it was something that a teacher reminded this term, [...].” R4; we have so many problems already developed, and maybe we could recycle some old ideas that were good, that worked, and it’s a waste we use the same idea only once...” R1; “[...] each term it’s a new problem, there is no problem database. Each session is a new problem...”. R3.

Designing problems is not trivial. It requires dedication, knowledge of the topic, and the affinity to write ill-defined problems with the features required by PBL. “There are situations that students interpret in a different way, and it’s part of the preparation of the problem, your leaving it a little open, I can’t leave the problem completely closed, I have to leave it a bit open...”. R3; “[...] I think I’ve never been that good to develop these PBL problems, it’s a great difficulty [...].” R5; “[...] preparing the problems, I think it’s a task that requires a lot of the tutor”. R4. The PBL problem is characterized, therefore, as a trigger to encourage students to develop critical thinking and problem solving skills.

Students who are able to finish the activities before the deadline can be bored with tutorial sessions. In this situation, the teacher should motivate them by using methodological devices. “[...] it was a challenge because there is no way they do not get a little discouraged, so I tried to say so – ah, shall we try to improve your work? How did you do it? Then I tried to bring them into discussion, so that he contributed to those colleagues who hadn’t finished, but at the same time they said so – ah, I have to go there just to clear doubts of the others, and mine is already done, so I tried this balance, but it’s hard...”. R1. Estimating the time students will take to solve the problem is difficult as well. “[...] I had no idea how long students took to advance through each step of the problem. Neither to measure what to ask, how long it would take, and how long they should take to solve the problem... so that was a big challenge to me [...].” R3.

The problem is an integral part of the PBL approach. Since the problems integrate knowledge and are usually multidisciplinary, it is important that at least most of the teachers take part in this task, either writing or reviewing the problem, and discussing how it unfolds in the tutorial groups. “It is important that problems are discussed among tutors before they are submitted [...].” R2; “Because when we prepare the problem, we think about the goals, which contents I must address according to the syllabus, then which contents I should address here, [...]. the initial idea, and prepare the problem, and everything together...”. R3.

A problem is only considered finished when students receive feedback. This lets them know where they performed well or poorly. “[...] a problem only ends when students receive feedback from the tutor...”. R4.

V. CONCLUSIONS

In this work, we performed an interpretative phenomenological analysis (IPA) to learn the essences of being a teacher in a problem-based learning (PBL) approach. Results led to seven essences, related to feedback, professional skills, assessment, problem design, teacher engagement, motivating scenarios, and group dynamics. Here, we described the four first essences in detail.

From the faculty point of view, we could better understand what it means to be a teacher in the active learning approach of PBL. Teachers revealed a strong difference between a lecture-based approach and PBL: instead of valuing content knowledge
and memorization, PBL values critical thinking, logic reasoning, reflection and real-world problem-solving skills.

However, PBL is not a silver bullet for all this illnesses of present-day higher education. It does not offer a satisfactory learning environment for each and every student. Students have different learning styles, and some may not adapt to a collaborative learning approach. Moreover, for being a student-centered approach, PBL requires teacher engagement and training. The approach also requires some extra hours of dedication and this may impair other faculty activities such as research and publications. However, less need to prepare lectures can make up for this additional time.

From the results, we were especially struck about the power of feedback and the value it has for students. It allows better follow-up and interaction with the teacher. With various feedback milestones, PBL lets students reflect on and evaluate their practices.

PBL promotes skills of group work, and it also stimulates individual study, according to students’ interests and individual pace. Thus, it develops better students and professionals. PBL actively engages students in a process of teaching and learning, with the knowledge being constructed through collaborative work and discussion.

Results also suggest that PBL contributes to increase faculty satisfaction with teaching activities, stimulating their professional development by means of intellectual challenges posed by students in tutorial groups.

This research provides a reflection on the teaching process in the PBL approach. A major challenge consists of learning to read between the lines, looking at the details of a teaching approach in its everyday practice. We believe that IPA helped to achieve this goal, and that it is a suitable research approach for uncovering the essences of teaching experience.

Further work should deal with additional analysis and reporting of the additional three essences not described in this work: PBL requires strong teacher engagement and background; it is essential to keep a motivating scenario; and good coordination and group dynamics is required. We also intend to perform an IPA with Computer Engineering students that live the PBL experience. It also seems interesting to contrast the essences uncovered in this work with the conclusions of the case reports produced and published by UEFS faculty.

ACKNOWLEDGMENT

The authors would like to thank the volunteers that took part in this research.

REFERENCES


