PROJECT-BASED LEARNING FOR TEACHER EDUCATION IN BRAZIL’S STATE WITH THE LOWEST LITERACY RATE

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Abstract
Alagoas’ educational system is among the worst performing in the world. To improve the situation for future generation of students, a better education for teachers is needed. While, for many years, teacher training in the region includes a theoretical discussion of modern didactic tools and methodologies, there exists a large gap between what future teachers hear at university and what they actually practice in their teaching. In this work we report on a pilot course to apply modern teaching methodologies during and as part of teacher training itself. More specifically, we employed Project Bases Learning in an evening course for working adults aimed at training maths teachers in Alagoas.

Keywords: Mathematics, Project Based Learning, Educating Working Adults.

Introduction
When in 1941, Stefan Zweig, an Austrian novelist, famously titled a book ‘Brazil, Land of the future’, he inspired Brazilians to the still common joke that “Brazil is the country of the future – and always will be’. The stagnated economic progress of this resource rich country, which features relative political stability and a potentially huge internal market, can be mainly attributed to its lack of an educated workforce. According to the Brazilian Federation of Industry (CNI, 2015), in 2013 only 48.7 % of Brazil’s industry workers have finished secondary education. The same report points out that in Alagoas, a state in the North-East of Brazil, this holds true for merely 18.9 % of the industry workers. A survey conducted in 2011 by the Brazilian government found that 24.6 % of the Alagoan population above the age of 15 is illiterate and a total of 26.5 % functionally illiterate (IBGE, 2012). Correspondingly, the students in Alagoas showed the worst results in all 3 areas (mathematics, literature and science) assessed by PISA in 2012 in Brazil (OECD, 2013b). Moreover, for all three areas their results are even below the
respective score in any of the 65 countries and economies around the globe participating in the study (OECD, 2013a).

Addressing this urgent socioeconomic problem clearly begins with well trained and equipped teachers who inspire their students to become an educated part of this promised ‘Land of the future’. One would therefore expect that improving teacher formation is a priority, and that future teachers receive the methodological, didactic and technical tools to incite their students to meaningful learning. Unfortunately, the very teacher formation courses consist of lectures upon lectures on theoretical discussions of methodology – yet never ‘do as they preach’, i.e. apply the advanced methodologies during the course itself. New teacher thus arrive at school without ever having seen or even experienced these methods in practice. It comes at no surprise that there is a big gap between what future teachers hear at university and what they actually do in class.

In this work we tested the hypothesis if applying teaching methodologies during the teacher formation increases the chances that new teachers later on will apply these methods themselves. We selected Project Based Learning (PBL) as the test-methodology and applied it in a class of mathematics ‘licenciatura’ students in the second half of 2013 at the Instituto Federal de Alagoas - IFAL (Alagoas’ Federal Institute). In Brazil, ‘licenciatura’ courses prepare students as future teachers in a specific subject. Although trained as math teachers, recent research shows that these new teachers are very likely to be employed to teach science subjects such as physics, chemistry, and at times biology (Fischer, Fireman, & Gomes, 2013). The specific course chosen from the math licenciatura curriculum for this test was ‘science education’ (preparing for the teaching of interdisciplinary ‘science’ classes at primary schools), with 3 contact-hours per week, attended by 13 adult students in evening classes. This research was designed to pilot the approach of applying different teaching methodologies at IFAL’s teacher formation and identify the best way to embed it in the curriculum.

Methods

PBL is a didactic method that is known to increase most student’s engagement and foster skills (Hattie, 2013; Planinšić, 2007), which is an increasingly important aspect in teaching (Bruns, Evans, & Luque, 2011). It is therefore a valuable tool in a teacher’s toolbox and is discussed, in various variations, in many teacher education programs. In our research, we used Carl Roger’s framework (Rogers, 1978), because of his emphasis on students bringing their own knowledge to the investigation and learning context, which combines well with andragogy (the majority of the course participants were over 30 years old). Malcolm Knowles (Knowles, 1970; Knowles, III, & Swanson, 2005) identifies the prerequisites for a successful formal learning situation with adults as: establishing a climate of mutual respect for each other’s experience; involving the learner in the planning and evaluation of her instruction, clearly explaining the purpose and relevance of the learning objectives, and teaching problem-centered rather than content-oriented. Paying attention to the learning characteristics of this period of life (Coll, Paláci os, & Marchesi, 1995), PBL is a suitable tool to incorporate the student’s
knowledge from work, hobbies, and personal interests into the learning experience, and, at the same time, to relate this knowledge and interests to the math and science teaching context and thus to their future professional activities.

The organization of the projects was purposefully held formal, to help the students develop valuable skills and abilities for their future profession, such as the capacity to work in groups, to write clear and objective reports, meet deadlines, gain intellectual independence and embrace the personal responsibility for their own learning. It has to be taken into account that almost all ‘licenciatura’ course participants at IFAL are working adults with family obligations, attending the course in evening classes. Due to competing duties at work, home and university, their course attendance is sometimes irregular and marked by fatigue, as observed by Togni and Carvalho (Togni & Carvalho, 2007). The course design therefore foresaw a limited time spend on course related activities outside the regular classes.

**Theoretical Framework**

Considering the formal learning context described above, Ausubel’s theory of meaningful learning (Ausubel, 2000) can be applied to the discussed implementation of Carl Roger’s project method (Rogers, 1978), which we choose as base for developing our PBL approach in teacher formation. Reflecting the course layout with these concepts helps to analyze the educational gain for the students and identify areas of improvements.

**Meaningful Learning**

According to Ausubel, the prior knowledge of students is the most influential variable in the learning process. In order to facilitate meaningful learning, it is therefore essential to gain an insight into the students knowledge and then teach accordingly. He goes as far as saying: “Teaching and learning are not coextensive – teaching is only one of conditions which may influence learning”. (Ausubel, Novak, & Hanesian, 1978, p.14).

Moreira (Masini & Moreira, 1982), commenting Ausubel, explains that the central idea of this theory is the crucial influence of the learner’s prior knowledge on the learning process. Each individual faces learning tasks with a already developed cognitive structure, and new information will be anchored on this structure when the learner interacts with them. This processes of anchoring new information to segments of the preexisting structure is called subsumption. Ausubel himself explain that

> “In meaningful learning the very process of acquiring information results in a modification of both the newly acquired information and the specifically aspect of cognitive structure to which the new information is linked. In most instances new information is linked to a relevant concept or proposition. … We will employ the term anchorage to suggest the role of the preexisting idea.” (Ausubel, Novak, & Hanesian, 1978, p.57).

Ausuble (Ausubel, Novak, & Hanesian, 1978, p.41-44) identifies two basic conditions for
meaningful learning taking place:
a) The new material to be learned must be relevant to the apprentice;
b) The apprentice must demonstrate a willingness to relate the new material non-arbitrarily and substantively to his cognitive structure.

Also according to Ausubel (Ausubel, 2000), the process of detailing, refinement and specification of a subsumer is called the *progressive differentiation* principle. In this concept, we start from the general (most important) and progress towards the specific (through examples, exercises and others situations). On the other hand, the process of exploring the links between knowledge, recombining them and relating them, seeking the differences and similarities between them, is known as *integrative reconciliation*.

**Carl Rogers’ and Oswaldo Frota-Pessoa’s approach of PBL**

Carl Rogers, a psychologist, developed the so-called Project Method (Rogers, 1978) as a predecessor of PBL. For Rogers, people are intrinsically motivated. Unfortunately the educational system often forces students to learn what is considered relevant for the social and economical system, but not what the student himself considers relevant and motivating.

Nowadays technology and science changes rapidly. There is a lot of knowledge being produced permanently, so it is essential that people be able to learn how to learn, to search, to pursue knowledge itself, and to become responsible for their own learning. Formal education is only temporary and acquiring new knowledge and skills needs to be continued by an intellectually independent learner long after finishing school. Rogers states that “the only man who is educated is the one who has learned how to learn, how to adapt and change, the one who knows that no knowledge is secure, that no process of seeking knowledge gives a basis for security” (Rogers, 1978). In order to help students to ‘learn how to learn’, Rogers develops his project method around 6 principles, which also where used to develop the PBL lesson plan for our research: 1. In order to facilitate self-initiated learning, the student needs to face a problem that he recognizes as relevant for himself. 2. The teacher’s responsibility is to provide adequate resources. 3. Students sign a contract detailing the project and learning objectives. 4. Students work in learning facilitating groups. 5. The teacher builds a positive environment, providing assistance and guidance without restricting independent learning. 6. The teaching approach makes use of simulations of real-world situation.

Another important author, related to the Project Method, is Oswaldo Frota-Pessoa (Frota-Pessoa, 2001). His work in this area has been very influential in Brazil. While his suggestions are in agreement with Rogers’ recommendations, he added that this kind of practice must consist of short, successive jobs, developed by teams that should generate reports, and these reports, at least partially, will make up the review. He says these projects should be presented, for example, in science fairs, or in a comparable classroom setting to the peers. He stresses the importance of the group’s responsibility to decide the project topic, plan its execution, manage its progress and report upon completion. According to Frota-Pessoa, the projects should be related to a common theme, which in
the case of this our research, was the development of a tangible educational tool for primary school science education.

Application to the course design

Combining the concepts from Ausubel, Rogers and Frota-Pessoa, the course layout encouraged students incorporate their professional experience and personal interests, which John Dewey (Dewey, 1929) aptly called ‘dawning capacities’, in their project work. The implementation of PBL was accompanied by theory lessons that provided the necessary background on writing projects, reports, and meeting minutes, on managing group work and presenting results. The theory lessons also discussed the quality metrics of educational material for primary school settings, such as developed by the groups in their projects. This allowed for a more formal organization of the PBL, including the writing of project proposals (including the contractual commitment suggested by Rogers) and reports, as well as to document the project progress and the contribution of the team members by meeting minutes. Students presented their work in an intermediate progress report as short presentation with projected slides and a concluding ‘fair’ at the course end (as encouraged by Frota-Pessoa). Relative to younger secondary-level learners, a much greater importance in the course design was laid on self- and peer-evaluation; already for the practical reason that a fair evaluation of project work is one of the greatest challenges the new teachers will face when applying PBL later on in class.

Results

Overall, the PBL approach was very well received by the students. None of the students had previously experienced PBL or a similar methodology. The 6 groups developed educational resources for teaching science in form of 1. a solar powered water heater; 2. a board game for teaching math; 3. a low-cost distiller for chemistry classes; 4. a wind turbine to generate electrical energy; 5. an electromagnetic cannon; 6. a filter to generate portable water from rainwater (not completed during the course). Since the students will graduate in at least two years after the test, it is not possible to verify in how far they use this methodology or the educational tools they produced in their own teaching practice. However, a preliminary evaluation can be derived from the statements made by the students, the teacher and an external observer who will later on evaluate the student’s production in a more detailed study.

From the teacher’s perspective:

The students were committed to the project in a surprising way, and demonstrated a positive attitude towards PBL methodology. Although most students (except two) had no teaching experience, they developed projects produced tangible educational tools suitable for teaching science at primary schools. However, I observed that most of the students lacked a deeper understanding of the science they were discussing. The course design was not successful at motivating the students to conduct research beyond the very minimum necessary to complete the project. Before PBL can be integrated in the
curriculum, several changes have to be made in the course design and the curriculum. In order to translate the content of pedagogical theory into practice, students have to be confronted with PBL much earlier, beginning in the first half of the undergrad curriculum, and then continue to practice it throughout the formation. A single course is insufficient.

*From the student’s perspective:*

The student’s comments after the final project presentation highlight five reoccurring themes:

1) Connecting educational and social reality: "The construction of the [solar powered water] heater improved the condition of my family because it has brought some electricity saving. Today we wanted to bring the heater [to the presentation in class], but it is already installed in my home and my wife is now using it."; "We chose to develop a wind generator because in our state there are innumerous houses without electricity, especially in the countryside …";

2) Understanding of PBL: "In the beginning we did not know what a project was, we couldn’t make evaluations of our own work or the work of others, after all, we are used to be judged by others, and we did not know how to make a presentation […] With the PBL methodology we created something new [a board game to teach math] and presented the project in an academic congress. With the teacher’s support we are writing our first article of many we intend to do”;

3) Self-efficacy: "When the teacher told us we could choose any subject to study I was paralyzed, not knowing what to do […] In the beginning it was difficult, but together with my colleagues… […] I also had to help some of my colleagues how to learn";

4) Assessment, feedback and reflection: "I had the responsibility to criticize myself and criticize the work of others. This is a hard work because we are not used to giving and receiving criticism. I was afraid that my colleague would get upset with my feedback, but, over time, we were seeing this as a useful evolution of our learning. Criticism, over time, became more natural";

5) Confidence to use PBL in class: "Based on the [short] time we've been working with PBL, I don’t feel myself prepared to teach with this methodology. I think we need more subjects taught with this method …”.

*In the external researcher’s view:*

“There were no observable dropouts with respect to the discipline or to projects, which were chosen and developed entirely by the students. With the exception of one group (water filter), the projects were completed and evaluated positively. Nevertheless, students showed deficiencies in conceptual knowledge as well as problems in completing the final reports with the information obtained from the meeting minutes. We observed that most students were inexperienced in basic methods to structure documents about their work. There were also significant differences between groups, their work approaches, in-group communication and activities carried out: Some groups, which had a regular class attendance, consisted of members who were committed to the project and produced good documentation. But the group members had to realize half way through
the course that their goals were unachievable within the given timeframe. In contrast, another group had set for itself clear and achievable goals. They also consisted of committed members, who, though not always present in class, progressed rapidly, and even tested the prototype of the game they developed with students at an elementary school (one of the members has been working in this school as math teacher). Yet another group consisted of silent workers. Although their project planning observed in the classroom seemed to be weak and making only slow progress, this group demonstrated a high commitment to their work, held frequent meetings at student’s homes and obtained excellent results in the end.

While in general the course participants developed a positive attitude towards PBL, they did not consider themselves sufficiently prepared to implement this methodology in their future professional activities. A single course in the curriculum using the PBL approach appears therefore insufficient to really move the participants to apply this didactic method themselves."

**Conclusion**

In order to address severe educational problems as they can be observed in Alagoas, it is essential to reform and improve the teacher formation process. Most of the professors training new teachers have gone to school at a time when the educational system was even worse than the current state, which is clearly marked by critical deficiencies, and have thus never experienced modern methodologies such as PBL at class. Likewise, students attending today the classes for teacher formation have never seen these methodologies in practice. To bring advanced teaching techniques and didactics to school, it is therefore important that future teachers experience them during their training.

In our research, which is meant to pilot such changes in the teacher training curriculum at a local institution, we found that using PBL is highly motivating for participating students, and that it helps them to relate their prior knowledge to the concepts they will later teach children in maths and science. The developed course layout is compatible with working adults studying at evening classes. However, students, teacher and an external researcher agree that a single course implementation of PBL is insufficient to prepare the participants for applying this method themselves. We also noted that the gain in conceptual knowledge was below the expectations, and that these deficiencies would need to be addressed by either adaptations in the course layout, demanding more research from students, or would need to be compensated in other courses.

**References**


