Study of the implantation of an experiential approach to science teachers’ training in Francophone minority communities: results from the second phase of a three phases design research

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Abstract. To remedy the problems of science teaching in francophone minority communities in Canada, we propose an "experiential" approach to train future science teachers. In this regard, our research aims to conceive and identify the conditions for implementing such experiential training, as well as evaluate its effect on the development of science teaching skills, as part of a collaboration between a university education faculty and two high schools in a French minority environment. The experiential approach had been implemented in one physics education course in a teacher training program taught in a Canadian university. To assess the achievement of our research objectives, we used qualitative methods, following a design research model. We report here on the results of the second phase of a three phases design research process. As for the implantation in local minority settings, some key findings are reported here from the second phase. Finally, we conclude by stating advantages and limits of our research.

1. Introduction
At the last survey conducted by the Program for International Student Assessment (PISA 2012) undertaken by the countries members of the Organization for Economic Cooperation and Development (OECD), Canadian students of minority education systems have scored significantly lower in science compared to their counterparts in majority education systems [1]. To remedy this situation, it is important that training programs prepare student teachers (STs) in Canada to meet the challenges of science education in minority communities by offering them a training approach seeking a better balance between theoretical and practical training [2].

To this end, we propose an "experiential" approach to science education training in minority settings in which student teachers (STs) are encouraged to explore their representations about science teaching and learning during lived experiences in these settings, to reflect on these experiences by linking them with prior knowledge, and to begin the process of inner transformation of their representations to improve their teaching skills in minority communities [3]. This experiential approach to science education training consists of the following phases (see Figure 1):
The commitment of the student teacher (ST) in a concrete experience, which is essentially to get in touch with a situation at school; 2) reflective observation, which enables the ST to objectify the situation and study it from different perspectives; 3) abstract conceptualization, where the STs tries to link the properties observed with a framework of interpretation (learning theories and teaching models) to conceive an action plan; 4) implementation when the ST verifies the plan conceived in the previous steps by implementing it in the chosen minority educational setting [4].

In this regard, our research aims to identify the conditions of implementation of this experiential training approach to science education within francophone minority schools and communities as well as evaluate its effect on the development of science teaching skills.

2. Methodology
The second phase of the experiential approach was implemented in one physics education teaching course during the winter session in 2015 by a member of the research team of a francophone education faculty in the province of Ontario. The syllabus of the course gave student teachers the choice between the experiential approach and a more traditional approach. Following presentation by the placement officer of the Center for Global and Community Engagement (CGCE) at the university, six students from the course chose the experiential approach and thus registered as volunteers to get involved in community engagement with high schools. The choice of the schools (2) were made on the basis of its proximity to the Faculty of Education, which allowed volunteers (6) to get there easily without affecting their studies. In the school, volunteer STs were involved in activities in average half a day per week. To help the STs to adapt to the culture of the schools, orientation sessions was given by the school teacher responsible to host and supervise the STs at the school, in order they could familiarize themselves with the characteristics and needs of the school in which they had to work. Alternating with their stay at school, they were introduced into their physics education course to the concepts, strategies and teaching tools of science education.

It is important to note that this second phase of the research was done within Design Research framework [5, 6]. As such, there are three main steps in design research process [6] : 1) analysis and exploration; 2) design and construction; 3) evaluation and reflection. The first phase, which was completed in the previous semester, had been was about to take contact with the school setting, analyse
the needs of the participants, and review the literature. These operations were taken concurrently, and one could say interactively, so that an initial prototype was conceived and tested in the chosen setting. Moreover, it should not be forgotten that, even if the stages of this research process seem well delimited, their systemic character implies that, at each iteration, a set of evolving prototypes, say prototypes 1-2-3, of the experiential approach was constructed and tested along the way (see fig. 2) [7,6]. Since the aim of this research is to increase the interaction between the school environment and the science education training environment, the first prototype and its followers must contain dispositions that take into account the characteristics and needs of these two environments, overcome their differences and eventually build bridges between them [8.2]. This is reflected in the figure 2 above by the double arrow between conception and implementation.

Figure 2. Design Research Process

To determine the conditions of implementation of the second prototype (second phase) in the target environments, qualitative methods were used such as the diary written by a member of the research team [9]. Moreover, we collected also documents produced by STs when planning activities for the school (e.g. lessons plans, videos, etc.) to determine how well those activities were fit for use in practice. As such, evaluation of these lessons plans were done in collaboration between the university professor and the school teacher on a formative basis. The results of these evaluations were communicated to the students through their emails. STs had thus the opportunities to make appropriate corrections. Regarding the qualitative data collected, we followed the method developed by Miles and Huberman & Saldaña [10] to classify data in predetermined categories or create new categories.

3. Results
We present here results of the implementation of the second prototype of the experiential approach in the Francophone schools in Ontario, focusing on identifying difficulties encountered, implementation processes, and adaptation of educational tools conceived by our STs to the context of selected minority communities. Implementation of the first prototype had been presented elsewhere [11]. Implementation
of the third prototype will be presented in an upcoming paper. In the following two sub-sections, we will describe the components and the implementation of the experiential approach.

3.1 Components of the experiential approach.

One important characteristic of the design research adopted here is that there is no clear demarcation line between the conception and implementation. Hence, the second prototype of the approach changes as implementation progressed as the result of the collaboration between the school and the faculty. However, what can be called the second prototype contained the following elements [12]:

1) Participation of student science teachers: Besides their activities in regular courses at the Faculty of Education, volunteer STs to the number of 6 had been involved through visits of half a day a week with the chosen school. Thus, STs had the opportunity to become familiar with the characteristics and needs of school environments. Example of activities where our STs got involved were: tutoring sessions with students after classes, designing science critical thinking activities, creation of videos to teach students the concepts of science and mathematics, planning of laboratory protocols, assisting schools pupils to prepare for science fairs, and being judges in science fairs expositions. It is noteworthy that some STs were involved in community engagement tasks in the two schools.

2) Attending physics education course: In their physics education course, STs had been introduced to various concepts, strategies and pedagogical tools of science education. Workshops were given about the nature of science that were aimed to inform STs about various theoretical frameworks and orientations regarding the nature of science and their relations with society.

3) Feedback and supervision: Since STs’ pedagogical knowledge may develop over time, it was necessary to plan ahead the approach of future teachers and to ensure that they not only had all that they require to continue their learning but also that they receive information about their own approach to correct it if necessary. In this regard, supervision of STs’ progress was assured in several ways. In the first place, formative evaluation was carried out by the professor in collaboration with the coordinators via the Google website. Moreover, STs had also to complete time sheets where they report their allocation of time to the activities chosen in the school which were later evaluated and commented by both the coordinator and the professor (see table 1). Indeed, since two schools were involved, two in site coordinators were chosen to supervise their work with the STs were at schools.

4) Communication: Communication was an important factor to foster collaboration of participants, say STs, onsite coordinator and professor. Information about various important events in the process, such as communicating the dates and times of meetings with coordinator, recalling the dates of returning assignments, etc., were done by phone and emails. The paragraph text follows on from the subsubsection heading but should not be in italic.

Table 1. Time sheet completed by a student teacher in community engagement service

| No | Date       | Duration (Hours) | Description                                           | Status   |
|----|------------|------------------|-------------------------------------------------------|----------|
| 1  | 2014-oct-09| 1 :30            | We discussed about tutoring in mathematics and the production of videos. After that, we will be assigned to days in order to… | Approved |
| 2  | 2014-oct-09|                 |                                                       |----------|
| 3  | 2014-oct-09|                 |                                                       |----------|
3.2 Unfolding of activities in experiential approach

We reported elsewhere, that upon first presentation of the project to the director of the school and science teachers at the beginning of the year, several objections were raised by the participants [11]. The first one was about the safety of students at school because they would likely interact with our STs. There was also some confusion between the experiential approach and a practicum. In this regard, several teachers were concerned about the additional burden their involvement in the project, such as supervising STs, could bring to them. These objections were not raised in the second phase, and the project was now well accepted by the school board. Indeed, we got more schools interested in the project that we could manage, due to the smaller number of the volunteers. The reasons of the drop in volunteers from the first prototype to the next are not well known. One main reason appears to be that community engagement projects in our university as a rule are linked to university courses and their professor. This rule meant that some students involved in the first phase of the project were choosing other courses and thus could not continue their involvement in the experiential approach. Some other causes as reported by some participants who declined was linked to their preparation to a faculty exam about language requirements they had to succeed in order to get their teaching certificate. This state of fact seems to point to a perception among certain students that the experiential approach is more work than the traditional one.

The two schools were part of the same school board. Each school nominated an on site coordinator of the project who was also a regular science teacher at the school. One of these two coordinator was also a master student at the faculty of education and played the role of project coordinator in the first prototype [11], Each STs volunteer was required to complete a 20 hours duration in community engagement tasks at the school.

The first placement was done at the school that first was involved in the first prototype. Under the supervision of the on-site coordinator, teacher and sector leader, the volunteers were asked to perform the tasks assigned to them, such as to provide support and help to students with specific learning needs. This placement was conducted as part of physics education course. Specific responsibilities of STs in this school included: 1) design of activities for the constitution of a substitute science binder; 2) participation in math tutoring activities under the supervision of a science teacher (required the presence of the future teacher at the school); 3) design of an educational video on a scientific theme of 7th or 8th year.

The second placement was conducted at the other school part of the same school board. It was placed under the supervision of another on site coordinator, a science teacher and head of sector. As in the first school, the STs volunteers were required to perform the tasks assigned to the them, such as support and assist students with learning needs. This placement took place within the same physics education course. Specific responsibilities of STs may have included: 1) act as a judge at the next science fair. Help young people prepare for their science project. Write a list of interesting topics for students in Grades 7 and 8. Write a list of questions that teachers might ask students to help them with their project. (Requires attendance at school); 2) design laboratory activities in the form of critical thinking (prediction-observation-explanation) at the 7th and 8th grade level. For example, on simple machines (pulleys, inclined planes, etc.).

All volunteers STs (6) chose one or more of these activities in one school or the two schools according to their interests to complete their twenty hours required for their participation in the project. It is noteworthy to state that all of them reached the 20 hours plateau and that many of them did more than the required time. According to their comments, STs enjoyed their involvement in the community, which had allowed them to become familiar with the characteristics and needs of teaching in minority communities sciences, although community engagement presented some challenges of their own. Various issues were raised by the participants that are presented here as examples.

The first students (ST1) mentioned that he learned a great deal about schools (free translation): “I can say that I learned a great deal about the needs of schools, and I tried to give my contribution to the laboratory activities, the activities proposed at the 7th and 8th grade”. However, he reported time and task management issues that made it difficult to combine community engagement with the
requirements of the teacher training program (free translation): “The real difficulty was to manage this activity with the intense program of the teacher training program because it was necessary at the same time to make the program and to participate in this community engagement. And sometimes the Internet resources were not enough, it was necessary to enter in the library to find some documents specific to these programs of 7th and 8th and having found the documents that allowed us to work and with the feedback of the teachers we managed to go beyond these difficulties and produce something interesting.”

Another student teacher (ST2) commented about his learning of what it takes to be a teacher: “At the pedagogical level, it was above all to understand that the task of a teacher is very loaded. And that a teacher cannot do everything, and that he always needs, he still needs help and support. If I want to be a teacher, I would sometimes need someone to help me, or a trainee or someone who is outside that can help me complete some task”. However, ST2 complained about the lack of clarity in teacher’s guidance from the coordinator he was assigned to (free translation): “It was mainly because it lacked clarity. We felt that the person (in-service teacher) was aware that she needed someone to volunteer to get involved but that we felt like a blur. Something that was not very clear. And we had to ask for clarification. And most of the times we had the impression that the person (i.e. the in-service teacher) needed us, at the same time, she was quite distant, it created a certain ambiguity ...”

Finally, a student teacher (ST3) commented about the opportunity that the project gave him to visit different schools: “I would say that it is above all to visit the schools, to see what happens in the different schools of being able to speak to professors, to see a little their style of work, needs, labors, and ambitions. I like the idea of attending different schools to have the chance to compare without necessarily having to spend an internship there”. He further added that he should have chosen community engagement tasks that involved more interactions with students: “Well, it was me who had decided in my community engagement to work on a presentation of the different software to teach different subjects or simply for class management. That I had found it well also because it allowed me to learn. At the same time, I liked that there is a surplus of interaction, it is the part that I missed the most in my community engagement. I felt like I was in my cave”.

4. Discussion and Conclusion
To implement the experiential approach in minority schools, it was important to address the concerns expressed by stakeholders in this environment. They should also agree on the rules of collaboration, and chose a school speaker who can bridge the gap between the two communities [2]. Furthermore, the use of information and communications technology (ICT) had allowed us to promote interaction between participants [13] and facilitate feedback with respect to the conception of activities by STs [14]. Finally, time constraints and scheduling, both by practicing teachers and STs, require a balance to be struck between the demands of university science education programs and the needs of minority education settings [15]. This research has helped us identify certain conditions to set up in order to implement an experiential approach in Francophone Minority Schools and assess qualitatively its effect on the development of science teaching skills within student teachers.

As for its effect on the development of science teaching skills, only the planning skills of our STs were evaluated. One of the school teacher rated them as satisfactory, although needing some refinement before they could be used for teaching. The other teacher did not evaluate them, due to prior engagement, and the task had been completed by their university professor. Regarding the limitations of this research, they include the convenience of site selection and the voluntary nature of participation that does not allow us to generalize the findings beyond the chosen site and our sample. We intend in future research to test the robustness of our results to other sites. One area of improvement that we intend to study in the third phase of this design research would concern the evaluation of teaching skills of STs while they implement their action plans in the school environment.

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