

ASSESSING PROFESSIONAL GROWTH OF PRE-SERVICE TEACHERS USING COMPARISON BETWEEN THEORETICAL AND PRACTICAL IMAGE OF THE 'GOOD TEACHER'

Ilana Lavy

Atara Shriki

Emek Yezreel Academic College

Oranim Academic College of Education

The aim of the study was to assess the professional growth of third year pre-service mathematics teachers (PST) during and after the implementation of a computerized project-based-learning (CPBL) approach into a didactical course. For this purpose we implemented an integrated tool - class discussion and portfolio. From the portfolios we could learn about the theoretical image of the 'good teacher' as perceived by the PST and from the students' presentations which were followed by class discussion, we learned about the practical image of the 'good teacher'. In order to learn about the impact of the CPBL on the PST's professional growth, we compared the resulting two images and received unexpected results.

INTRODUCTION

Following the NCTM's (2000) recommendations for integrating inquiry activities into the mathematics curriculum, we exposed our PST to innovative teaching methods and educational theories, hoping to support their professional growth. However, we had no indication whether this exposure did indeed contribute to their professional growth. Therefore, we looked for valid tools that would provide us with maximal information regarding each student's gradual development and growth. Based on our diverse experience in assessing PST, we decided to use an integrated approach for assessing our PST professional growth: portfolio and classroom discussion.

In the current paper we focus on the information gained from the portfolios and the class presentations, which were followed by class discussions. The comparison between the data received from the portfolios during the period of their experience in the CPBL approach and the data received from the class presentations enabled us to assess the professional growth of our PST. Professional growth can be expressed in various manners, such as developing perceptions regarding: content knowledge, didactical knowledge, and knowledge concerning the learners. In the scope of this paper we chose to focus on the changes in the perception of the image of the 'good teacher' as an indicator for the PST's professional growth. We focus especially on changes in the PST's perceptions regarding didactical knowledge a 'good teacher' should hold and exhibit.

Contextual framework and background

One of the courses we teach deals with theories and didactical methods implemented in teaching and studying geometry and algebra in junior high school. The vision that was generated by the NCTM's (2000) standards regarding the image of the new generation of mathematics teachers had made innovative approaches to teacher education compulsory. In order to become aware of the various processes associated with the implementation of novel methods, we believe that the PST should experience them over a long period of time. One of those recommended methods is learning through self-exploration. To engage our PST in a genuine process of exploring important and meaningful questions we implemented the method of studying through Project-Based-Learning (PBL). PBL is a teaching and learning strategy, which enables students to work relatively autonomously over an extended period of time, during which they pose questions, make predictions and decisions, design investigations, collect and analyze data, use technology, share ideas, build their own knowledge by active learning, and so on (Krajcik, Czerniak and Berger, 1999). We termed our approach as CPBL (Computerized-Project-Based-Learning) since it rested heavily on the use of computer software.

Assessment of professional growth

Considering this context we wished to assess each student's: a. Gradual improvement of mathematical knowledge; b. Development of inquiry skills; c. Conceptual formation of didactical knowledge. All three dimensions are rather difficult to define and assess. Since each aspect requires a lengthy discussion we shall limit ourselves to the assessment of the third one, which is recognized as a significant and important component of teachers' knowledge as a whole (Even & Tirosh, 1995).

Consequently, two main questions are raised: what is 'didactical knowledge', and how to assess its formation? As for the first question, Shulman (1987) refers to didactical knowledge as an essential component of teachers' knowledge. Shulman (ibid) suggested seven categories related to teachers' knowledge, such as: content knowledge, general pedagogical knowledge, knowledge of learners and their characteristics etc. As to the second question, there is no agreed way for assessing the formation of didactical knowledge. Thus, we chose to formulate our own belief regarding that issue. For that matter, we focused on the way the PST perceived the image of the 'good teacher' before and after experiencing the CPBL. We believe that in referring to that image one must consider various aspects regarding didactical knowledge.

Assessment tools – portfolio and classroom discussion

Choosing the appropriate tool was important for us to enable the PST to reflect on the processes they were experiencing, since personal development occurs by reflecting on activities (Cooney & Krainer, 1996). Additionally, through reflection students may become aware of the viewpoints that lie behind their mathematical performances in terms of what it means to solve problems and to reason (NCTM, 2000), as well as

to develop new ways of making sense of what it means to do and teach mathematics (Simon, 1994).

Holding in mind the important role of reflection we decided to employ an integrative assessment tool: classroom discussion and written portfolios, since we believe these tools provide the opportunity to reflect on processes. As follows we shall briefly review some of the characteristics of classroom discussion and written portfolios.

Classroom discussions provide insight into students' thinking (NCTM, 2000). Discussions in which students communicate mathematically, present and evaluate different approaches to solving complex problems can develop their sense of criticism towards the quality of solutions. Consequently the capacity to reflect on solutions and to engage in self-assessment is increased. Teachers' questions during class discussions promote the abstraction of ideas, so that extension of the new ideas may derive spontaneously from the class discussion (Simon, 1994).

Portfolio is a record of one's process of learning. It is a purposeful collection of examples of work collected over a period of time. Portfolio includes what one has learned, how one thinks, how one creates and analyzes things. As such, it enables the evaluation of the learner's progress and performance (Arter & Spandel, 1991). In using portfolio as an assessment tool the focus is on the learner's successes rather than his failures. As a consequence portfolio has the potential to motivate students and to advance their ability to reflect on the processes they are going through and to carry out self-evaluation. Various studies on the use of portfolios have indicated that they could usefully serve purposes of assessment of professional competence and development (Campbell et al, 1997).

METHODOLOGY

The research data came from two main sources: *a.* The PST portfolios which included continuing reflections regarding the process they were experiencing and their responses to a written questionnaire that was given before and after the implementation of CPBL. One of the issues they had to relate to in those questionnaires was the image of the 'good teacher'; *b.* our observations of the students' presentations in which they reported their progress in the project and the class discussions that followed them.

Each resource had its unique contribution to the assessment of the PST professional growth. However, since they mutually stimulated each other we could gain a view of each student's current state as well as the processes that led her/him to that state. Looking for phenomenological categories, we applied inductive analysis (Goetz & Lecompte, 1984) on the data collected from the written portfolios referring to the students' experience with CPBL and the class presentations and discussions. We considered all the students' utterances through the lenses that concerned their perception of the image of a 'good teacher', before and after working on the project,

as well as the reflection on their experience with the CPBL approach, and their presentations in class.

From the portfolios we could gain a sense of the PST's 'theoretical' image of the 'good teacher', before and after experiencing CPBL, while during the class sessions we could observe the 'practical image', as was exhibited by the PST. In order to assess the entire professional growth as was reflected from the resulting three images, we made a comparison between them.

THE STUDY

25 PST in their third year of studying towards a B.A. degree in mathematics teaching participated in the course. CPBL is one of the main methods of learning in that course. The students could choose to work individually or in pairs. The project was geometrical by nature, and the students used dynamic geometrical software in the various stages of the project. The project included the following phases (Lavy & Shriki, 2003): 1. Solving a given geometrical problem, which served as a starting point for the project; 2. Using the 'what if not?' strategy (Brown & Walters, 1990), to create various new problem situations on the basis of the given problem; 3. Choosing one of the new problem situations and posing as many relevant questions as possible; 4. Concentrating on one of the posed questions and looking for suitable strategies for solving it; 5. Raising assumptions and verifying/refuting them; 6. Generalizing findings and drawing conclusions; 7. Repeating stages 3-6, up to the point in which the student decided that the project had been exhausted. In each class meeting part of the time was allocated to class discussion, during which the students raised their questions and doubts, asked for their classmates' advice, and presented parts of their work. The students were required to write in their portfolio at least once a week and to send us a copy by e-mail. We then returned our feedback. The problem we were facing was which items should be included in the portfolio. We decided to give the PST the autonomy to include anything they wished in their portfolios in order to learn which aspects they believed they had to reflect on. The only instruction that was given was a general one, namely to describe all the aspects that concerned their way of thinking and working, including their progress, difficulties, experiments, conjectures, doubts and so on, and to reflect on them. Our feedback was not a judgmental one. We asked mainly for further clarifications and elaborations and suggested new viewpoints.

RESULTS AND DISCUSSION

We first refer to the professional growth as was viewed from the portfolios, then as was observed during the presentations, and finally we compare between them. In the scope of this paper we refer only to aspects relating to the didactical knowledge the 'good teacher' should poses and exhibit according to our PST.

Professional development as was viewed from the portfolios

In this section we refer to the PST's utterances regarding the didactical knowledge the 'good teacher' should hold and exhibit. These utterances helped us to draw the 'theoretical image' of the 'good teacher' as was perceived by the PST.

A. References to the didactical knowledge of the 'good teacher' before experiencing the CPBL

Before experiencing the CPBL the most common utterances of our PST regarding the didactical knowledge of the 'good teacher' were (indicated by b_i): b_1 . *Knows to explain well*; b_2 . *Teaches in an interesting manner*; b_3 . *Adjusts the learning materials to the students' level*; b_4 . *Tries various teaching methods in order to find the optimal one*; b_5 . *Uses many examples and games*; b_6 . *Learns from his mistakes and avoids repeating them*; b_7 . *Can solve every mathematical problem*.

We distinguished between declarative and operatively oriented utterances. By declarative utterance we mean a general statement without recommendations for implementation, and by operatively oriented utterance we mean utterances that imply or include practical operations. Part of the above utterances is declarative (b_1, b_2, b_3, b_4) and part of them is operatively oriented (b_5, b_6, b_7). Declarative utterances were more frequent than the operatively oriented ones. Among them, the most frequent utterances related to knowledge about teaching methods and strategies (b_2, b_4, b_5). A minor part of the PST's utterances implied to knowledge about the students (b_3).

B. References to the didactical knowledge of the 'good teacher' after the experiencing of the CPBL

After experiencing the CPBL the most common utterances regarding the didactical knowledge of the 'good teacher' were (indicated by a_i): a_1 . *Creates a good atmosphere in the mathematics lessons*; a_2 . *Inspires the students to look for a deep understanding and not just success*; a_3 . *Teaches attractively*; a_4 . *Develops creative thinking*; a_5 . *Encourages his students to ask questions*; a_6 . *Motivates his students to experience the process that a mathematician goes through while looking for a mathematical regularity*; a_7 . *Spends a great amount of thinking in the design of a lesson*; a_8 . *Provides his students the opportunity to explore mathematics, and does not give them the solutions right away*; a_9 . *Lets the students think first and then establishes the subject matter*. a_{10} . *Explains each topic clearly and simply*; a_{11} . *Uses many examples in class for clarification*; a_{12} . *Integrates interesting activities in his teaching*; a_{13} . *Enables all the students to take an active part in the mathematics lessons*; a_{14} . *Uses many class discussion*

From the above utterances we can see again that they can be divided into two kinds: declarative utterances (a_1, a_2, a_3, a_4, a_5 and a_6), and operatively oriented utterances ($a_7, a_8, a_9, a_{10}, a_{11}, a_{12}, a_{13}$ and a_{14}).

After experiencing the CPBL approach, operatively oriented utterances were more frequent than the declarative ones. The utterances pointed to a much **more**

comprehensive didactical knowledge, and related more broadly and specifically to knowledge about teaching methods and strategies (the most frequent were utterances a_8 , a_9 , a_{11} , a_{12}) as well as knowledge about the students and knowledge about class management (a_{13}, a_{14}). The ability to give a detailed list of characteristics that relates to knowledge about the students, knowledge about teaching methods and strategies and knowledge about class management the 'good teacher' should hold, point to the PST's professional growth.

Professional development as was viewed from the presentations

The class presentations and the classroom discussions that followed them enabled the tracing of the practical implementation of the changes in the PST's perception regarding the image of the 'good teacher'. These presentations helped us draw the PST's 'practical image' of the 'good teacher'.

The class presentations began approximately at the middle of the semester. Each pair of PST had to present his work in class, to describe the problem situation that was chosen, results that were discovered, and difficulties that accompanied the process. For the presentation, most PST used Power Point and the dynamic geometrical software, which helped them to demonstrate clearly their geometrical problems and ideas.

The most visible change during the class presentations was the shift from 'lecture based' presentations into interactive ones. That is, during the first few presentations, the presenters focused primarily on talking about the difficulties they encountered while working on the project. Moreover, the presentations were rather vague and unfocused, and we had to function as mediators between the presenters and the class.

As time passed, the presentations became more structured. The presenters succeeded in handling a classroom discussion, and could explain clearly their ideas and doubts. They become aware of their classmates' comments, listened carefully and asked for further clarifications when needed. Nevertheless, many of them asked us to postpone their presentation claiming that they had not reached complete results, and said that they were afraid of being asked questions they would not be able to answer.

Theoretical vs. practical image

Tracing the revealed PST's 'theoretical image' before and after experiencing the CPBL, implies professional development. There was an obvious observed shift from declarative to operatively oriented utterances. Moreover, the utterances were more specific regarding the didactical knowledge the 'good teacher' should hold and exhibit in his class.

However, observations of the presentations revealed a different picture. Although there was a shift from perceiving the 'good teacher' as one who has to lecture his ideas to one who has to be in a constant interaction with his students, still most of the PST exhibited an approach which was consistent with the theoretical image that was drawn before the experiencing of the CPBL. Namely, the interactions were limited

only to situations in which the presenters felt safe with the problems they brought into the discussion. Moreover, the PST did not bring to the discussion any problems that they were not sure of their solutions. Relating to the utterances mentioned above, it is clear that the PST still believe in utterance b₇. In addition, they did not exhibit any behavior regarding the contents of a₂, a₄, a₅, a₆, a₈, and a₉.

To summarize, it might be said that the analysis of the portfolios revealed that the 'theoretical image' of the 'good teacher' had undergone a meaningful change as a consequence of experiencing the CPBL. Yet, observing the 'practical image' of the 'good teacher' as was drawn from the presentations and the class discussions that followed them leads to a different conclusion. That is, there was not a real change in the PST's general perception regarding what good teaching really means.

CONCLUDING REMARKS

The use of the integrated tool for assessing our PST's professional growth revealed unexpected results. When we examined only the outcomes that were received from the portfolio regarding the PST's perceived image of the 'good teacher' before and after experiencing the CPBL, we could observe professional growth. This professional growth was concluded from both the shift from declarative to operatively oriented utterances and from the nature of the utterances after experiencing the CPBL. Namely, with comparison to the utterances that were uttered at the beginning of the semester, the PST's utterances after experiencing the CPBL were more comprehensive on the one hand and more detailed on the other. The utterances referred to a larger scope of attributes regarding the image of the 'good teacher' than the ones that were uttered at the beginning of the semester. However, when we examined the image of the 'good teacher' as was revealed from the presentations and the class discussions that followed them, we realized that the PST demonstrated a behavior that matched the image of the 'good teacher' as was perceived before experiencing the CPBL and not after it. Consequently, we could observe a wide gap between the theoretical and the practical image of the 'good teacher' after the implementation of the CPBL approach.

Thus we suggest that any evaluation program aimed at assessing professional growth of PST should include both components: one that enables the assessment of the development of theoretical ideas and one that enables the assessment of the development of practical experiences. The comparison of the results received from both components will enable the evaluator to draw a much more reliable picture of the actual professional growth of the PST.

Further research is needed in order to understand the reasons that underlie the gap that was found in our study regarding the PST's perceived theoretical and the practical image of the 'good teacher'.

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