Scratch to foster pre-service teachers' creativity*

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Abstract. Although creativity is a key component of mathematical activity, the Mathematics lessons at school are rarely related to creative work. This situation could be reversed if the teacher training programs included some specific training in how to enhance students' creativity, among other factors. The aim of this paper is to present the redesign of an activity in order to promote pre-service teachers' creativity. The first design of the activity was implemented in a group of secondary school pre-service teachers from a master's degree in teaching in secondary school (specialization in Mathematics). The implemented activity was used to introduce the programming language Scratch, the teacher and the document that the pre-service teachers had, guided the activity. In the redesign, based on the seminars of the DoCENT project, some important characteristics are changed to make it a more open activity and to improve the interactions between the participants. These aspects are usually considered as helpful to enhance creativity.

Keywords: Mathematical creativity, Scratch, Secondary school pre-service teachers.

1 Introduction

The mathematical activity is usually identified as creative [5, 8], despite lessons at school rarely promote students' creativity. Several authors [2, 4, 5, 7, 8] highlight the importance of enhancing students' creativity since they start school and doing it for all the students, and not only for those that have good marks. Mathematical creativity at school level is frequently associated with posing and solving problems, including processes such as modelling, generalization, making connections and validation [2, 5, 7]. In accordance to this, the teacher training programs could include some training in how to promote students' creativity at school. The aim of this paper is to present the redesign of an activity implemented with a group of secondary school pre-service teachers, in order to promote their creativity. By the practice of this type of activity, they could also think on how to promote their future students' creativity.

2 Context

Activities presented here were designed for a group of secondary school pre-service teachers, from a master's degree in teaching in secondary school (specialization in Mathematics). This activity is included in the course of Material and LKT resources in Mathematics education. The course consists of 5 sessions of 4 hours each. Only one session is completely dedicated to LKT resources. In this session, pre-service teachers work with Geogebra [3] and Scratch [6]. Only the activities with Scratch are commented in this paper. The master's degree does not include a specific training in how to enhance students' creativity.

3 First design

The main objective of the first design of the practice with Scratch [6] was just to introduce the programming language. In order to do so, two exercises were planned. The pre-service teachers have a document with the description of the exercises.

3.1 First exercise

The first exercise consisted in guessing what a sequence of blocks will produce, before executing it. The sequence made the mascot draw a square. All the steps followed by the mascot were identified with a particular block, no loops were used. First, the pre-service teachers should predict the result and copy the code to check their answers. Then, they were suggested to change the code in order to get the mascot oriented in a different way. After this, they were suggested to use the block Repeat to optimize the code. The last question was the generalization of the sequence to make it useful to draw any regular polygon. In this case, no instructions in advance are provided, just the possibility of using a variable to introduce any data after the mascot's question.

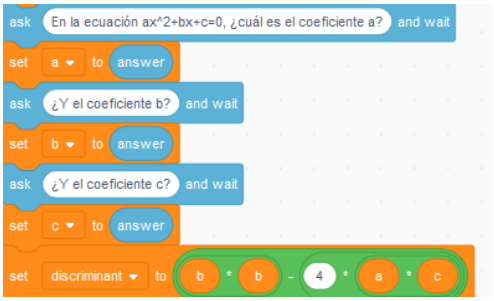

Fig. 1. Example of some steps in the second exercise

3.2 Second exercise

Thinking on how the pre-service teachers could use Scratch, the objective is to program an algorithm that secondary school students use frequently. In particular, they design a

program that calculates the roots of a quadratic equation given their coefficients (see Fig. 1). Some tips are provided in the description of the exercise, for example how to use the variables in Scratch. Also, the pre-service teachers are prompted to think on which condition is necessary to assure that the equation has real solutions.

4 Implementation

In order to assess the implementation, I will use the didactic suitability criteria of the Ontosemiotic Approach [1] as a guide. The didactic suitability is divided into six types: epistemic, cognitive, emotional, interactional, mediational and ecological suitability. For each suitability criterion, some observable components and characteristics enable us to assess the implementation of a teaching and learning process in practice. Only some of the components are commented here.

The activity was implemented in a group of 31 pre-service teachers. The session of 4 hours included the practice with Geogebra [3] and Scratch [6]. The pre-service teachers received a document with all the exercises at the beginning of the session. It was not necessary that they did all the exercises, they could choose those that they found more interesting. If they had some experience with the programs, they could do the exercises on their own; otherwise, the teacher selected some exercises to do all together, guiding the resolution. They did not have to present any evidence of their work at the end of the session. In addition, they worked individually, each one used their own computer, although they could talk to other classmates or ask questions.

4.1 Epistemic suitability: Mathematical processes

There are some mathematical processes that could be remarked in this activity. In the first exercise, the pre-service teachers have to identify some elements that combine the use of non-specific and specific mathematical vocabulary. For example, the turns (to draw the square) are expressed in degrees. Then, they automatize part of the code. Finally, they make a generalization of the whole process. In the second exercise, they have to construct the algorithm of the quadratic formula and then transcribe it using the Scratch language. In this case, the mathematical model is predetermined.

4.2 Mediational suitability: Time and material resources

The pre-service teachers were especially interested in Geogebra [3] because the teachers in the master's degree usually talk about it, although most of the pre-service teachers had not used it much. In addition, some days after, some of them were participating in an event of the Catalan Association of Geogebra, so they wanted to know the basics of the program before attending the event. This made that most of the session was dedicated to Geogebra and it only remained one hour for the Scratch practice. Some pre-service teachers were working on their own, instead of following all the exercises that the teacher presented. They could have started with the Scratch exercises before, but they did not. Regarding the resources, the computer lab was not available, so the pre-

service teachers had to bring their own computers. Since they had different versions of Geogebra, they could not work with it as fluently as they wanted. Nevertheless, they did not have this problem with Scratch because they used the online version [6].

4.3 Interactional suitability: Students' interactions and the teacher

Most of the pre-service teachers participated actively in the class discussion. In this session, when they had some problems with the programs, they asked the teacher or other classmates, if the teacher could not answer in that moment. When there was a problem that the teacher considered especially relevant, then the teacher presented it in the blackboard to discuss all together. For example, in the first exercise, when they had to do the generalisation of the program for any regular polygon, they doubted how to calculate the turn of the mascot. The question was presented in the blackboard. Some of them had already calculated it and gave their solutions. Afterwards, they noticed that when they increased the number of sides of the polygon, the mascot failed in the drawing. In this case, the reason of the error in the drawing was not in the code programmed, the mascot cannot complete some movements if it arrives to the borders of the screen.

5 Redesign

This redesign has been developed based on the seminars of the DoCENT project in which I participated. First, the activity would be in pairs or groups of three, since this distribution facilitates the interaction between the pre-service teachers. They would be asked to try to solve their questions in the little group, before asking the teacher. Moreover, the time dedicated to the activity should be increased. Indeed, the first exercise, that would be the same, could be done in a session before to introduce the programming language and dedicate two hours in another session to do the new activity. The second exercise would be changed. The pre-service teacher could choose what they want to program, it is not necessary that they use the quadratic formula. The new phases of the exercise are described as follows.

5.1 Design of the application (at least 20 minutes)

In this phase, they have to choose which type of equation they want to solve and which method they will use. Once they have decided what they want to do, they have to think on which tools of Scratch [6] can be useful to do that. The teacher can intervene if there is a technical problem. If there is a comprehension problem and the pre-service teachers cannot solve it, the teacher will start a dialogue with them to clarify their objectives.

5.2 Programming the application (at least 30 minutes)

In this phase, some errors can be expected, but the pre-service teachers should try to solve them on their own. If they cannot detect an error, the teacher can suggest them to separate the blocks and execute them in order to find in which point the sequence does

not work properly. If there are several groups that have the same problem, the teacher should prompt them to discuss the problem together.

5.3 Final discussion: How could we use it with future students? (at least 40 minutes)

In this final phase, there is a discussion with all the group about what they did, difficulties and improvements. After this, they should think on how they would implement the activity in a secondary school class: working on pairs/groups, time, teacher's intervention. Finally, they could also explain their expectations: objectives, possible difficulties.

6 Conclusions

With this redesign, the activity would be more open, not so guided as in the first design. Some authors remark the openness as a characteristic of activities that can be useful to promote creativity [2, 7]. In particular, in Mathematics, open problems usually generate more diversity of the mathematical processes that are involved in the resolution, than close-ended problems. In addition, more time should be dedicated. This is especially important to improve the interactions between students. They need time to think on how to solve the task and the possible errors that appear. Interactions are also an important aspect [4]. Pre-service teachers would participate even more and the teacher would not be the only reference of knowledge, they should listen to other classmates to solve their problems and check for the validity of their answers. The assessment regarding creativity is also a key aspect that we should address in a further redesign of the activity.

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