

Student reflections as an influence in the dynamics of an introductory programming course

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Abstract – Learning computer programming is known to be difficult for many students. In the context of a wider study, which aims to design a pedagogical strategy for introductory programming, we decided to use some less conventional activities. This strategy was applied in the last three academic years with some success. In this paper we will discuss a component that proved very relevant, the biweekly reflections we asked the students to write during the course. They were expected to reflect on the course, the different activities, their learning, the difficulties felt, and any other aspect they considered important. The analysis of the texts written gave the teacher several hints that lead to some successful individual interventions. From a research point of view this analysis gave also some important clues to the refinement of our pedagogical strategy.

Index Terms - Programming learning, Interpersonal relationship, Cognitive feedback.

INTRODUCTION

Researchers and teachers worldwide have been trying to understand the reasons why initial programming learning is so difficult for many students [1] and to design strategies and tools that may contribute to improve the situation [2].

It is possible to find in the literature many studies and suggestions about CS1 problems [3]. To induce a meaningful change in the current situation it is necessary a comprehensive approach that must include different tools and pedagogical strategies that may address each student difficulties and needs [2, 4]. It is also important to invest in the quality of communication between teacher and students, so that difficulties can be identified and students' involvement can be increased [5, 6]. In other words, putting into practice actions that reinforce the students' emotional involvement with the course could be good to support the adopted pedagogical strategies and to assess if students are learning as expected.

Any pedagogical strategy should make students aware that they are able to learn to program if they put the necessary effort in the learning process. It is important to value contexts and establish class dynamics that may motivate students to work, convincing them that individual difficulties can be solved if they get ready to "learn to think" [7, 8]. This should lead to a higher student commitment to their learning, including behavioral changes that may improve their performance throughout the course.

A good part of what we learn, either from will or need, involves motivation that must be developed through a continuous process, which includes intrinsic and extrinsic strategies to evaluate, stimulate or change the individual appetite to do or not do something. It is also important to allow the students to express themselves and give feedback about their learning process and their feelings about it. This could be achieved through feedback activities, making students practice their communication skills and give useful information to the teacher that may use it to improve the interpersonal relationship dynamics in the classroom.

COMMUNICATION AND MOTIVATION IN CLASSROOM

Often students decide to dropout from programming courses because they lose trust on their own abilities, thinking that it is the only solution for their natural inability to learn to program. It is important that they learn to be persistent and not to give up when faced with difficulties, especially because often students do things wrong well before they start to do things right. Teachers must try to fight this tendency, and explain the difficulties inherent to learning to program and how students can face them [8].

Many students are not able to explain the difficulties they have. Also, it is often hard for teachers to identify the difficulties and the kind of support each student needs. Communication and interpersonal relationships in these matters is a valuable weapon, but for most students and some teachers, building a safe communication channel is not simple [9].

TEACHING TO THINK APPROACH

Our research aims to identify the characteristics of contexts that may make learning more stimulating, minimize dropout intentions and make students learn more and better. We look for guidelines regarding contexts and didactic activities, computational tools and motivational measures that may assist teachers in the definition of specific learning contexts for programming courses [10].

The proposal was developed under the perspective of learning communities, inspired by a metaphor of Matthew Lipman's Communities of Inquiry [11]. Lipman's proposal is an appeal to teachers to focus their practices in guiding students in a search for knowledge, motivating them to consciously identify what they already know and what they need to know. It is important not only to solve a problem, but also to be able to think on and assess the quality of the solution. This approach usually involves collaborative

interactions and an investment on a good teacher-students communication channel. Although the pure philosophical speech is not enough to teach programming, the methodical and reflective thought that comes from the dialogue inspired in Science Philosophy can be useful to improve the student's reasoning and thinking skills. The communication and literacy skills improvement that may result from this approach can also improve the classroom dynamic, make the students more comfortable to participate and make the learning process more attractive [12,13].

We designed a strategy that includes didactic activities planned to strengthen the student's involvement with the process of knowledge acquisition, to develop their problem solving competences through teamwork and to motivate them to collaborative knowledge production activities, such as: small projects, research activities, peer tutoring and programming challenges. To stimulate extra-class activities and to facilitate monitoring and continuous assessment tasks, we used the Moodle learning management system.

It is important to include in any pedagogical approach some form to gather information about how students feel during the learning process, the difficulties they experience in each stage, the activities that motivate them, how confident they are about their own abilities and so on [8]. This information can be gathered through formal instruments to measure personal perceptions, self-confidence and self-efficacy [14], but we chose to ask students to write periodic reflections about the course and their learning.

This pedagogical strategy was put into practice in the academic years 2008/09, 2009/10 and 2010/11, in the context of a Programming course included in the Master on Design and Multimedia. Although it is a master course, most students had no previous experience on programming. Some of them had bad experiences in their previous arts studies. Considering the students background we used the Processing language, facilitating the utilization of many graphical examples and exercises in the course.

The strategy included several common components, like individual and group works, small tests and a mini-project. It included also less usual tasks, like a seminar on programming utilization to create artistic projects, peer-reviewing of some assignments and a mandatory biweekly reflection each student had to write. The strategy and its two first implementations in a real setting are described in detail elsewhere [15].

THE BIWEEKLY REFLECTIONS ACTIVITY

In this paper we focus in the probably less conventional activity in our strategy: the biweekly reflections. Students were asked to reflect about their own learning and its difficulties, and to express their views about course related issues, like tasks, materials, the pace of classes, and any other aspect they felt relevant. The students had to write their reflections using Moodle's diary activity, allowing only the student and the teacher to read them.

The reflections allowed the teacher to have more feedback from the students, especially because some

students felt freer to write about their difficulties than to speak about them in class. As a consequence, knowing each student specific difficulties allowed the teacher to address them directly, through some intervention in class or a direct contact with the particular student.

Our first objective was to know more about the students and to identify those that might need a more personalized intervention, in order to increase their motivation, confidence levels and involvement with the course activities [13]. However, we also realized that a final analysis of the information collected might give us useful information to improve the pedagogical strategy.

An interesting aspect, not foreseen in the beginning, were some behavioral changes we noted in some students after they had to write in their reflections that they hadn't committed enough in the previous weeks (even if the cause was work in another course). The simple fact that they had to write it (they were expected to reflect about the causes of their difficulties) induced a higher commitment in the next period, possibly because they wouldn't like to write the same again, knowing that the teacher would read it.

THE INTERVENTION PROCESS

Since the number of students involved in the Programming course was small (around 20 each year), the whole process to assess the biweekly reflections was conducted manually. In all three experiments we conducted a final content analysis [16] over the information collected.

The students had scheduled weekends to make new entries on their diary. After each deadline the teacher read the reflections and tried to identify the aspects that could give him some clues about the learning process evolution, the student's personal perception and the kind of motivation issues they presented. When significant difficulties arose the teacher tried to intervene to minimize them. Sometimes the problems affected several students and justified a class intervention or a change in the planned activities. Some other times the problems detected were specific of some student and an individual intervention was made. In some specific situations, student's reflections gave the teacher some clues that made him become alert regarding possible dropouts. For example, a student who had missed several classes wrote "*I have nothing to say...*". This led to an individual intervention and she admitted the intention to quit the course. The talk made her change her mind, and with more commitment and some extra help she managed to be successful in the course. In other cases the teacher intervention wasn't enough to change the student's behavior.

Sometimes, after some poor performance, the teacher informed a particular student that she had low possibilities to be approved in the course, but advised her to keep working to develop her programming skills and have better chances to get approved in the course next edition. This was reflected in the student reflection "*Even if I haven't passed the mini-tests I will continue working for the course because I know that I need to practice a lot.*"

In some occasions, after the grades in an assignment or mini-test were published, the sense of frustration was high in many reflections (e.g. *“I don’t feel motivated. I have never been a brilliant student in programming and after this test I feel a sort of frustration about study and about what I do and the results I can achieve.”*) In situations like this the teacher made indirect interventions for all students during the class, trying to explain what went wrong and helping them to manage and overcome their frustration. These interventions also included alerts that they would be able to recover, but extra work was necessary.

Every time we implemented the strategy, most students had a negative initial reaction when told that they would have to write a reflection every two weeks. However, in most cases they later reached the conclusion it was positive: *“doing biweekly reports increased my critical analysis sense, even if sometimes filling in the reports was inconvenient, making me deliver them beyond schedule”*.

Some reflections gave the teacher some useful information about what students were feeling in some moments: *“Yet I felt more comfortable knowing that many people had less contact with programming than I did and faced the same difficulties”* or *“I also found interesting that the teacher called us to comment on our work so that we could know what to improve in the next test”*.

The teacher could also know the student’s opinion about specific aspects of the course: *“The test simulation was good to realize the difficulties I have in programming”* or *“The evaluation method seemed the most correct one and I agree with it. As it’s a Programming course, learning is much more fruitful when challenges are launched continuously, allowing an exponential learning curve”*.

The information collected each year in the student’s reflections was also considered to decide the adjustments to be made in the pedagogical strategy in the next year.

SOME RESULTS

After the end of each course we did a more systematic content analysis of student’s reflections, trying to find information that might help us to improve the pedagogical strategy. We followed the process proposed by Bardin [16]. The content was organized in thematic items and the adopted encoding rules were the following:

- **Cutting:** The unit used included the ideas expressed in the texts and the context unit was each reflection paragraphs, even when they were very short or merely descriptive.
- **Numeration Rules:** In direction we use positive, negative and neutral polarity. In the quantitative approach we use frequency and in qualitative approach we use presence of themes in the speech;
- **Classification:** The contents were organized into categories considering semantic criteria.

It is important to highlight that during the process some categories were reassessed to be in accordance with the ideas expressed in the texts.

I. The First Experiment

In the first year, which we call MDM1, the course included 15 participants, with 7 scheduled reflections. The aim of this activity was to verify the coherence our approach and the dynamics generated by the strategy. In the end we crossed the information we had got from the biweekly reflections with information collected through informal interviews with the students. The results of the interviews corroborate the aspects identified in the reflections. In this phase the categories identified were:

- **Learning Activities:** When they evaluated and commented learning activities;
- **Class Dynamic:** When they made suggestions and assessed several aspects about classes, such as rhythm, contents, amount of work, teacher’s performance, etc.;
- **Didactic Materials:** When they evaluated and commented about all support materials (exercises, workgroups themes, text book, class slides, etc) and the programming language;
- **Competences:** Identification of competences and abilities they developed or they needed to develop to learn better;
- **Behaviors:** Indications about student’s attitudes and behaviors shown on the speech.

Figure 1 shows the number of positive and negative references classified in each category. Students were quite pleased with the learning activities, as well as with the adopted class model. However, they assessed negatively the didactic materials available, as well as they showed some negative views about the evolution of their own competences and behaviors (commitment especially).

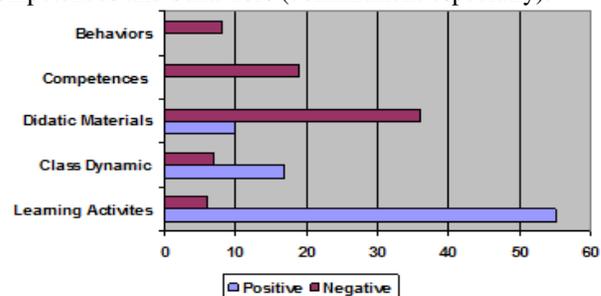


FIGURE 1
RESULTS IN THE FIRST YEAR.

In the didactic materials category we included references to the exercises made in class. As we usually proposed exercises that were beyond student’s current knowledge (as a way to raise the need for some new concept or programming structure), many students complained in the reflections about the problems’ level of difficulty. Also it became clear that students preferred visual exercises to number based problems.

II. The Second Experiment

In the second year, called MDM2, there were also 15 students (one of them had failed in MDM1). The number of reflections was 8. This time we created some specific

categories to better identify some aspects present in the texts:

- **Teacher Performance:** Evaluation of the teacher’s attitude;
- **Expectations:** Indication of the level of confidence on their own performance;
- **Competences:** Analysis of the difficulties and identification of the competences they developed or they needed to develop to learn better;
- **Feelings:** Expression of feelings found in their speech, including mentions to previous programming experiences.

Figure 2 shows that students have once again evaluated very positively the class model, and this time there was a specific highlight for the teacher’s performance, possibly due the close individual monitoring. Students also showed some evolution in their reflexive levels concerning their learning needs. However, they show little confidence in their own capacities as the number of negative expectations, frustrations and insecurity is high.

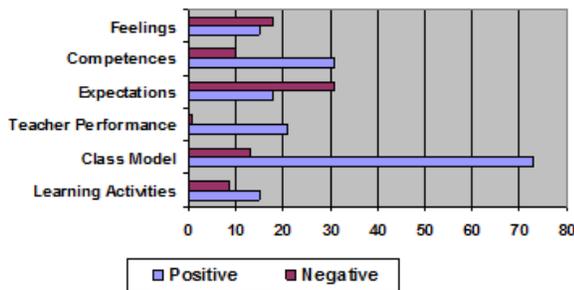


FIGURE 2
RESULTS IN THE SECOND YEAR

III. The Third Experiment

In the third year, called MDM3, we had 20 participants, three of them had failed in the previous year and one was repeating to improve the grade she had got. The number of reflections increased to 10.

Student’s background was different this year. Instead of having mostly arts students, there was a higher number of students coming from communication and multimedia courses. They had some previous contact with programming, although most of them mentioned bad experiences. Figure 3 shows the results obtained in the third year.

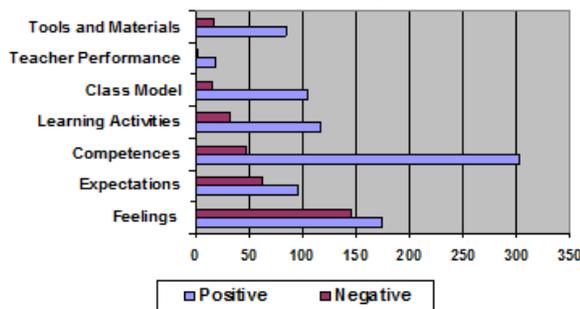


FIGURE 3
RESULTS IN THE THIRD YEAR.

Looking at the graphic it is possible to see that students often made references to the improvement of their competences and abilities. However, there is a clear contrast with the high number of negative expectations and feelings expressed (insecurity, frustration or lack of motivation). These negative feelings appeared essentially in the beginning of the course (maybe due to their past experiences), and after knowing the results of a test where many of them didn’t have good results. Students had to face the fact that they needed to work more and improve their learning strategies.

It is interesting to note that we identified many records related with learning improvement and coping strategies, associated with insecurity records. This shows some reflexive work not only in the sense of acknowledging their limitations, but also the willingness to seek ways to overcome obstacles.

The scores related with class model and the teacher’s performance are much lower than in previous years. Although those items references are more positive than negative, it seems students focused essentially in their learning and feelings. This is a good sign, as one of our objectives with the reflections was to raise student’s conscience about their learning, and what they had to do to be successful.

It is interesting to note that some students explicitly mentioned the importance of writing the reflections to learning. Besides, reflections had an important role in promoting teacher-students communication, as one of them wrote “and last but not least important, I think this idea of critical reflections good, even as a communication facilitator tool”.

IV. The Final Categorization Analysis

After the end of the third experiment, all reflections were reevaluated and re-categorized, so that we could obtain a better information outlook. Most aspects mentioned in the biweekly reflections were the same in the three years. Many students complained about the amount of work and the high difficulty level of the course. Although many students showed some resistance to the amount of work involved, in the end most of them concluded that those activities were extremely important for their learning.

Based on the data gathered we looked for an answer to the following question: What is the student’s perception about the learning process within the course?

We found two large categories, one that includes all information related with the students performance, called Student Factors, and another that concerns the student’s evaluation of the pedagogical strategy, called Strategy Factors. Into those two categories we organized five sub-categories. The first three belong to Students Factors and the last two belong to Strategy Factors:

- **Competences:** All records about competences and abilities implied in programming learning and practice, both developed or needed (learning

strategies, coping strategies, difficulties, reflection on the limits and needs of learning);

- **Previous Experience:** All records that refer the positive or negative influence of their previous programming experiences;
- **Feelings:** All records that express negative or positive feelings (motivation, expectations, relief, reward, frustration, insecurity, etc.);
- **Organizational:** All records that make some evaluation of pedagogical aspects (learning activities, classroom dynamic, teacher performance, tools and materials);
- **General Impressions:** general expression of satisfaction/dissatisfaction, descriptive texts and suggestions for course improvement.

Figure 5 shows an analysis of the data gathered in the category “Organizational”, which groups student’s evaluation of different aspects of the pedagogical strategy, as this was one of the main objectives of our work. We can see that the number of positive statements about the four sub-categories considered is much higher than the number of negative statements. This is particularly relevant in the sub-categories “Classroom dynamic” and “Learning activities”, as they group the most important aspects of our pedagogical proposal.

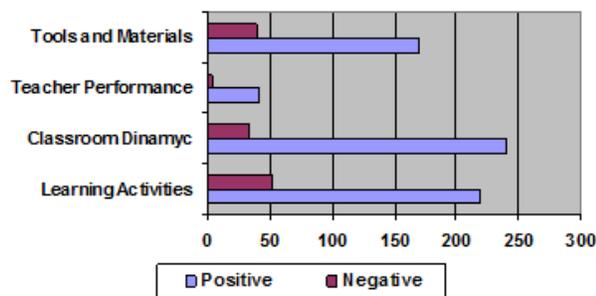


FIGURE 5

STRATEGY FACTORS ANALYSIS – ORGANIZATIONAL CATEGORIES.

Figure 6 shows the General Impressions category data. It supports the idea that most of the students make a positive evaluation of the strategy followed, as satisfaction is more frequent than dissatisfaction. We can also see a significant student involvement, as they made several suggestions for the course improvement.

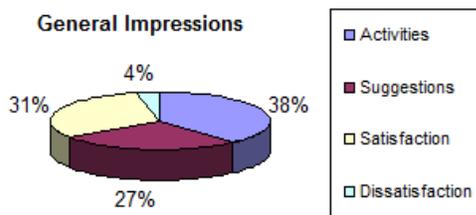


FIGURE 6

STRATEGY FACTORS ANALYSIS – GENERAL IMPRESSIONS.

The data collected in the Students Factors category is presented in figure 7. It is important to note the quantity of

negative feelings (frustration, disbelief in their own abilities to learn and lack of confidence) expressed, especially after important assessment moments where the marks weren’t as high as the students would like. This shows the importance of some intervention in those moments, trying to transform those feelings in more commitment instead of dropout.

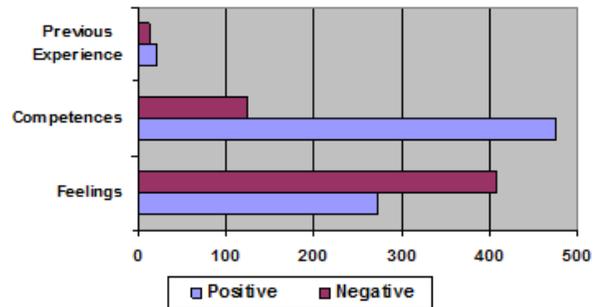


FIGURE 7

THE STUDENTS FACTORS CATEGORIES ANALYSIS.

We can also see a high number of positive mentions categorized in “Competences”. This is essentially due to the student’s reflective effort about their own evolution, especially when they were able to solve some difficulty or learn some new concept. This also reinforces the feeling that students managed to improve their confidence, believing that the effort spent would make them succeed in the course.

We could also conclude that most negative aspects, even those related with student’s past experiences, were about their fear to underperform, and not with the course itself.

CONCLUSIONS

The biweekly reflections were the strategy component that raised more doubts to us. We had no past experience in the utilization of this type of activity. We feared that students would resist to it and also there was the conscience that it would mean extra work for the teacher.

We cannot say for sure if the biweekly reflections influenced the quality of interpersonal relationship in these courses, although we believe they did. We can definitely say that they had a huge influence on student’s involvement and learning behavior. During the content analysis, we noticed that almost all students shared many important emotional hints, not just about their learning, but also about their feelings.

The information gathered during the course about the classes, about the students feelings, and their expectations and fears, helped the teacher to know the students better than usual and build a confident classroom environment. That is why we consider the biweekly reflections were particularly important.

This activity is a small example where we could bring back the Socratic didactic approach claimed by Lipman, also an attempt to create an emotional bond between the teacher and the students.

The teacher makes a positive evaluation of the strategy in general and the biweekly reflections in particular. This is

due to the results obtained, but also the communication and confidence levels it was possible to establish. A better knowledge of the students allowed the teacher to make the interventions and corrections he felt necessary. Also, the need to express themselves made students more aware of their learning and what was necessary to improve it.

The reflections were positive even in situations where a student did not work enough in some period. The simple fact that they had to recognize that in writing raised their conscience of it and the need to correct the situation.

However, the teacher also acknowledges a significant increase in his work, when compared with more conventional approaches, mostly because the time necessary to read the reflections and implement measures to correct them.

The students' enthusiasm and success convinced us that to increase student's motivation to learn programming is a key issue. To achieve that goal it is necessary to establish a good classroom environment, and to have a good teacher-student communication and relationship.

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