V CLABES

QUINTA CONFERENCIA LATINOAMERICANA SOBRE EL ABANDONO EN LA EDUCACIÓN SUPERIOR

HOW TO PREVENT DROPOUTS IN INTRODUCTORY PROGRAMMING CLASSES: A STUDY INVOLVING FACTORS FROM STUDENT PERSPECTIVES

Línea 3. Prácticas curriculares para la reducción del abandono.
Métodos que promueven aprendizaje activo (aprendizaje basado en problemas, empleo de TICs para mejorar el desempeño).

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Resumen. In Brazil, more and more students come to college with deficiencies related to writing and comprehension skills regarding the Portuguese language, logical and mathematical reasoning as well as a lack of researching habits. These deficiencies have been identified as impacting and relating to dropout rates in Algorithms and Programming courses. Brazilian and international studies point out the need to create methodological strategies and extracurricular activities in order to help students overcome their lack of background. However, most studies present the issue from the teacher's point of view regarding the factors he/she judges to be involved in the dropout process. Usually, these factors are derived from elements related to formal assessment (tests, tasks and exercises). The differential of this study is to analyze student perspectives and see how much this truly connects with reality, considering today's incoming digital generation of university students. We sought to identify which other motivational and structural factors lead these students to drop out from the courses considered. This study was carried out in two parts. Part one was published in [14] when we presented a case-based qualitative, descriptive analysis using testimonies from undergraduate Computer Science students who dropped out or canceled the course before the end of term during three semesters (2012-2013). We sent the same online questionnaires to another group in 2013, during the second semester, and the results did not change. This research enabled us to reorganize the way we teach these students in a methodological approach. Though these results are related to the Brazilian reality, we believe these results can contribute to discussions related to this topic in other contexts.

Palabras Clave: Dropouts. Teaching Algorithms and Programming

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1. Introduction

The dropout rate at introductory levels in Computer Science programs is not new. Many national and international authors have studied this situation. Unfortunately, this situation is frequently observed in other areas related to hard sciences and generates a deadlock situation. We need more Engineers, Computer Scientists and people to work in the technology industry. So, this problem concerns society in general. Regarding Computer Science programs, the causes have been vastly studied and several hypotheses were considered in order to try to explain what has been causing this serious problem. According to [26], the student dropout rate in higher education is an international problem, which affects the outcome of education systems. The loss of first-year students causes social, academic and financial losses. In the public and private sectors, resources are invested without return. In both cases, dropouts can be understood as a source of idle faculty, staff, equipment and physical space.

The high investment in higher education should not only be measured financially. We must consider the social, emotional, and human resource costs that the dropout effect causes. Each student who fails to contribute their intellectual capital and labor towards society negatively impacts the quality of our lives. In the area of computing, this problem is recurrent and a source of investigation for many researchers. We investigate the results of several research projects related to teaching and learning Algorithms and Programming, considering the most significant proceedings in Brazilian events: the Brazilian Symposium on Computing in Education (SBIE), the Workshop on Computer Education (WEI) and the Workshop on Informatics in Education (WIE), all promoted by the Brazilian Computer Society. This paper also mentions some of the challenges faced by learners regarding this topic, according to the authors of articles published in the three events. One reason for the steep dropout rates is the difficulty students have with the content and skills in the Algorithms course [15], which aims to develop logical reasoning to solve problems in different areas of human knowledge. According to [18] and [19], the educational practices of teaching algorithms have become the subject of numerous studies to minimize dropouts.

Despite efforts to help students learn programming, many programming students are failing programming courses all around the world. While the lack of problem-solving skills is viewed as a possible cause of failure in learning programming, another potential reason is that students may hold non-viable mental models of key programming concepts which may lead to misconceptions and difficulties in solving programming problems as mentioned by Aureliano, Tedesco (2012), Bayman,Mayer (1983). Many researchers have tried to improve the learning of programming. Soloway was a pioneer. Aureliano, Tedesco (2012) reported that familiarity with the problem domain helps novices understand the programming problems that they are asked to solve. Bonar, Soloway (1985) concluded that natural language skills seemed to have a great impact on students' conceptions and misconceptions of programming. Researchers have argued for the theory that prior knowledge of a programming language has a negative impact on learners' attempts to program in a second language. Bayman, Mayer, 1983 chose to teach programming by way of formal reasoning. Other researchers, such as 10.Iepsen at al (2011) have concluded

that people who know how their programs work are more successful than those who do not.

In previous publications Giraffa, Moraes (2012), Giraffa , Mora (2013) and Giraffa et al.(2014), we identified the scenario caused by student dropout rates in these undergraduate programs as the object of study of both the SBC (Brazilian Society of Computing) as well as IT (Information Technology) professional associations, such as SOFTEX (www.softex.br) and ASSESPRO (assespro.org.br). By analyzing existing studies, including Aureliano, Tedesco (2012),Bayman, Mayer (1983),Bonar , Soloway (1985), Gomes at al.(2008),Hernandez, at al (2010), Iepsen at al (2011), Jenkins (2002), and Silva Filho at al, (2007), and also from our own experience as professors of algorithms and programming, with over 20 years of experience, we have observed that studies seek the opinion of teachers who have taught this course. Moreover, based on their reviews and observations, they often point out that the drop/cancel rate of this course occurs for the following reasons: mother tongue difficulties with written language, interpretation of texts and utterances, study and research habits, and especially a deficit regarding the content of basic Mathematics. The differential of this paper is the investigation of student perspectives to see how much this truly connects with this generation of students that is familiar with the internet and technology resources. We sought to identify which other motivational, structural and socioeconomic factors have led students to drop these courses. In this sense, this study involves a qualitative case-based approach, supported by the testimony of undergraduate students in Computer Science programs at a private university in Brazil. To collect data for the analysis, we consider four consecutive semesters from 2012 to 2013. We selected those students who dropped the course or canceled before the end of term. Data collection took place via an online questionnaire sent to students, who were then selected based on student registration cancellations in virtual classes associated to selected Programming Algorithm courses. These courses are given in the first semester of Computer Science and Information Systems programs.

2. Research Methodology

The qualitative approach, based on a case study, allows us to highlight the work done in a universe of meanings, causes, expectations, beliefs, values and attitudes characteristic of social contexts. According to Yin (2010), case studies can provide significant advancement in real knowledge of a specific context. Thus, this approach integrates research interests, since it allows for another look at the dropout process from the student viewpoint. A questionnaire was developed using the Forms tool available in Google Drive and sent to all students who canceled the course between 2012 (1st and 2nd semester) and 2013 (1st and 2nd semester). A total of four semesters was considered for the research base. The total number of students who responded to the invitation to complete the questionnaire in the first stage was 89 students. We removed those students who answered the questionnaire more than once. In the second step, we consider 36 more students. The total number of students enrolled in each semester is an average of 150 students divided into 5 classes. The set of enrolled students was 600. However, many of the students repeated because they had previously dropped the course. Therefore, we needed to check the

names in order to obtain the valid data set. The set of students who answered the questionnaire is 252. We were very excited about the results because 125 students gave us the completed questionnaire. The data were collected in the last two weeks of each semester in 2013. We know that, for cultural reasons, most of our students check their University email only sporadically and few redirect the email to their private accounts. We were warned of this "student stop-by culture" and we would welcome feedback on this difficulty. Facebook and Twitter are the preferred tools for students to communicate. We considered using these resources to reach students, but were faced with a fundamental question: we are not "connected" to the students via Facebook and Twitter. This is not an official record and so we were limited to using institutional tools of communication (academic email) to collect the information with all the restrictions inherent in the choice made.

3. Data Analysis and results

The research subjects were distributed in terms of gender male (89 %) and female (11 %) following the distribution pattern found in both Computer Science programs nowadays. Ages were arranged in 3 groups: 17-21 years, 22-30 years and 31-43 years, with a different distribution in each course. Since 2013, we have observed a change in the profile of Computer Science students in relation to Information Systems. The Computer Science students are younger than the Information Systems students. Regarding their occupation, 82% of the Information Systems students worked with a minimum workload of 20 hours per week, most with more than 30 hours of weekly activities. This leaves them with little time to study and to carry out extra school activities. The Computer Science students mostly did not work (80%) and they have time to study and do extracurricular activities. It causes a huge impact on the way we need to organize our classes and pedagogical approach. Our challenge is to maintain the quality of teaching in both programs by creating different strategies regarding pedagogical methodologies. It is a wake-up call for all of those who believe we can teach the same courses despite the different student profiles.

96% of the students have their own computers so they can study and 4%, who do not, use the computers at the university or those provided by the company they work for in their study-related activities. When asked about the hours they can devote each week to their studies, again there was a difference between programs. In the Information Systems program, 85% said they have less than 10 hours per week to devote to their studies, 12% can devote 10 to 20 hours per week and only 3% have more than 20 hours per week for their studies.

Regarding the "lack of time to study", 74% of Information System students stated that this is an important and decisive factor for dropping out. In the Computer Science program, the causes for cancellation do not have to do with the lack of time to study. The main cause is regarding a lack of motivation because they do not understand what they need to do. Again, the lack of comprehension skills regarding Portuguese language statements appears to be an important issue. We made a series of statements inferring possible causes related to course cancellation. Each of the statements asks respondents to rate the statements using the scale: 5 -Decisive factor for me to cancel, 4 -Important factor for me to cancel, 3-Neutral, 2-Somewhat important factor for me to cancel, and 1-

No relation to cancellation. We highlight some interesting information from the data and comments made by students. Regarding the question related to the statement "I did not do the suggested exercises", the data indicated that 34% of the students from both programs indicate this as a significant factor versus 36% who said it was not important, while 30% chose the neutral option. It seems to us that this is something to think about with respect to homework and extracurricular activities. The tasks and exercises are fundamental in order to fully develop programming skills.

Regarding the number of absences in classes, 60% of the students thought it was important, 21% were neutral and only 19% thought it had no impact. We found this to be a very curious result, since student absences from the classroom and their involvement in work-related activities during on-campus classes are usually factors considered to be a cause of dropouts by teachers and the literature cited in this article. Maybe there is some relation to our methodology based on virtual classes created on the MOODLE platform. More information can be found in Giraffa, Moraes (2012). With respect to understanding (comprehension of) class topics explained by the teacher, 36% of the students did not think it was important, 15% were neutral and 49% felt it had no impact. This shows clearly that if the student cannot follow the teacher's explanations and does not understand the content in class, it will negatively impact their personal studies out of class. Again, it is strange that some students in the sample considered this factor to be neutral or unimportant. Again, according to the teacher's point of view, this seems contradictory since, if they understand the lesson and use it to reinforce their study, this seems to be an element of support for extracurricular study. Especially for those students who do not have much time to study outside of the university.

With respect to previous knowledge of elementary Mathematics skills, 52% of the students did not think it was important, 26% were neutral and 21% felt it had no impact. Again, this contradicts the teaching point of view since formal-logical reasoning is very import and fundamental to programming. This leads us to a new investigation in order to understand the reason behind these answers. We infer that other causes must be or may be making more of an impact on the students that is placing this issue in the background. Teaching students to program is notoriously difficult. Substantial failure rates plague introductory programming courses the world over. It has increased rather than decreased over the years.

Regarding the difficulty to understand the utterances in exercises, 17% of the students did not think it was important, 22% were neutral and 61% felt it had no impact. At this point, the teacher viewpoint is plausible since understanding that which is being proposed in the exercises, clearly identifying the problem and its parts are critical to solving the proposed tasks both in the classroom and in extracurricular activities. Students have great difficulties understanding the statements they read, leading us to an additional concern related to prior readings and understanding the texts. This point motivates us to carry out a specific investigation to understand the causes of this, since the students have gone through the school system, the selection process for university admission where they had to interpret questions and write an essay. In this sense, it remains to be seen whether the flaw is in the system as a whole. Do we have "functional readers", people who can read a text but do not understand the

essence of it? Our guess is linked to the fact that they have not been encouraged previously in the education system to solve problems from a statement and critically analyze what is being asked. How to solve this gap is a challenge imposed on us.

Regarding the statement "personal organization to manage my time," 31% of the students did not think it was important, 30% were neutral and 49% felt it had no impact. A significant portion of students believes organization helps improve studying. This percentage changed when studying in the 1st phase, where most of the students believed that this was not a significant factor.

Regarding the statement "did not ask questions in class when I had doubts", 58% believe that asking questions in class will not help their understanding some topic. This is alarming because participating in class, asking questions and developing critical thinking, trying to analyze what is presented and clarifying doubts is essential for anyone studying. Not just for those studying, but as a healthy behavior and instigator to learn anything, in any life situation. The same question comes up again. Why not motivate our students to be more critical (argumentative) in the best sense of the word? We should motivate them to more deeply pursue an understanding of the problem instead of passively accepting the solution presented by the professor during classroom interactions.

Regarding the statement "I have not studied the books suggested", 39% of the students did not think it was important, 30% were neutral and 31% felt it has no impact. Again, we have an important issue to be investigated. Lack of reading habits and seeking additional information causes a lack of a deep understanding related to class topics. The lack of reading and the aforementioned difficulty of understanding what you are reading create a vicious cycle: "I do not read because I do not understand and I do not understand because I do not read." Three open questions were asked on the questionnaire. Clearly, as expected, some students gave answers charged with emotional responses; some students took the opportunity to register complaints against teachers and specific infrastructural situations. This is natural in a poll of this nature, especially when anonymity is guaranteed. For us, the main open question was: What was your main motivation to cancel the course? The following aspects led to dropping/cancelling courses. Note that some respondents indicate more than one reason as a motivator for cancelling: lack of time to study, inadequacies of teaching practices by the professor, and the lack of understanding.

Several respondents mentioned the need for better teaching practices in order to help them build significant knowledge.

4. Final Considerations

The result of the survey indicated a slightly different perception from what is found in the literature. The literature highlights the prerequisites of Mathematics, logical thinking and problem-solving skills as the most important. However, factors associated with a lack of time and understanding of what is expected in exercises appear to be the most important elements for students. Comments regarding pedagogical and methodological aspects seem to influence the prevention of dropouts. Dropouts cannot be associated to a single factor. A number of factors can contribute to a student cancelling a specific course. Students who have a heavy workload tend

to have less time to devote to studying and they end up finding it difficult to pass and perform well in the context courses. Obviously, this cannot be used as an element towards organizing a program that is below standard quality. However, it is clear that the lack of time and motivation seems to influence the dropout rate. Teaching and learning strategies should be varied. The use of diverse elements to support the teaching process, the use of different media resources, a careful selection of writing activities, encouraging extracurricular reading for students can contribute to preventing course cancellations. However, this is not enough. There are external factors and the individual circumstances of students, which contribute to dropouts. We extend our research to identifying the factors that emerged from analyzing the data. Moreover, we will continue using current tools in the pursuit of more opinions in order to update and / or strengthen the indicators found. Most students, especially those in first year computer science, find learning programming very difficult. Researchers have been working on finding ways to help students to learn programming using various methods and tools. The next step will consist of identifying which factors are related to students' 'motivation to persist in their choices and overcome their difficulties related to programming learning. The information found in this study is not only applicable to courses in computing, but present aspects that can be generalized to other areas of knowledge.

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