

Active Learning as a Substitute for Traditional Methodology, Under the Field of Computer Science

A study of the best approach to learn computer science subjects according to Computer Science students of University of Brasília

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ABSTRACT

Universities have been substituting the traditional methodology of teaching (industrial method) with the active learning methodology. So the goal of the paper was to find the best approach to teach to students of computer science in the University of Brasília.

We used an online questionnaire to reach a large number of students and ex-students of the university. Excluding student who was not from computer science and students from first semester.

In the data of the survey reach 60 students of computer science valid responses. Most of students agree that active learning should be substitute traditional learning methodology. d

KEYWORDS

computer science, active learning, problem based learning, education, methodology, students, university

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1 INTRODUCTION

In 2014, the dropout rate of Computer Science (CS) in the University of Brasília (UnB) was of 55.76% and it was getting worse. This problem can be related to the teaching methodology used by the professors of UnB. Because of that, we will study how the computer science students in that university sees active learning as a substitute for the traditional methodology.

The traditional methodology can be seen as a class where the responsibility of the student learning falls on the professor. Active learning is a methodology that inserts the students as the main responsible for learning. So students do more than just listen to what the teacher says and participate more on the production of knowledge.

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Universities around the world, like MIT, University of Leicester and Hiroshima University, have been using this method and their data shows that it improved learning and reduced dropout rates. Even in Brazil there are universities that are using active learning in some of its majors, like *Escola Superior de Ciências da Saúde (ESCS)* and *Centro Universitário de Brasília (UniCEUB)*.

The active learning methodology, also known as European Method has been showing effects on the capacity of learning of the students. With that in mind, its clear that there is a necessity of applying this methodology in the area of Computer Science, given that the dropout rate is very high.

The methodology used by a professor is up to him and in some cases, the methodology can be ineffective. If we can show that students prefer the active learning methodology (as they feel they learn better), we could reduce the dropout rate in UnB and increase the university learning rate for the Computer Science Bachelor.

This paper is organized as following: Section 2 presents the problem and the approach to solve it; Section 3 presents the theoretical research, showing the most important and relevant papers; Section 4 describes the approach of the research method and how the questionnaire was created; Section 5 presents the answers given on the questionnaire; and finally Section 6 discuss about the results.

2 CONTEXT

The traditional learning methodology is widely used in Brazil and it has been this way in centuries. Some courses in UnB have changed the methodology to the active learning method in the computers science major. The members of this paper have experienced courses with that change, with Problem Based Learning (PBS), and felt that this was a better way to learn computer related subjects.

PBS is a method where the professor defines a problem to be solved in a time and every lecture is focused on helping the students to solve the problem without doing it for them. The professor just guides the student and it is the student the responsibility to learn what is needed to solve the problem.

Using the data collect from a survey purposed in this paper, we can see how the students felt when they experienced active learning classes and with that have a feedback of the students toward the traditional methodology.

3 SYSTEMATIC LITERATURE REVIEW

Systematic Literature Review is the usage of systematic methods to collect secondary data, critically appraise research studies, and

synthesis studies. Systematic reviews formulate research questions that are broad or narrow in scope, and identify and synthesize studies that directly relate to the systematic review question. They are designed to provide a complete, exhaustive summary of current evidence relevant to a research question. Systematic reviews of randomized controlled trials are key to the practice of evidence-based medicine, and a review of existing studies is often quicker and cheaper than embarking on a new study.

3.1 Collection methodology

The articles were acquired in the platform *Google Scholar* using keywords like "active learning methodology", "computing" e "learning in computer science".

3.2 Critical Appraise

3.2.1 Important Articles.

- (1) Nagai, Walter Aoiama and Izeki, Claudia Akemi in [7] report that engineering is one of the human activities that allow social and technological change through technological innovations. With that in mind, there is an enormous need to use active learning methodologies that show the students of Engineering courses problems or projects that allow observing real world situations. The paper presents a report on the usage of a cooperative active learning methodology in students from three different engineering majors.
- (2) Costa, Heitor Augustus Xavier and dos Santos, Rodrigo Pereira in [3] showed in their paper the objective of presenting the importance of a well taught course of algorithm's fundamentals and programming in computer science bachelor, listing some of the teaching problems of some of the course content with some strategies researched in the literature to try to solve them.
- (3) GOUVEA, Eduardo P and Odagima, Andrea Mayumi and Shitsuka, Dorlivete Moreira and Shitsuka, Ricardo in [5] presents a case study performed with students from the bachelor in Information Technology from a private university located in the southeast Brazil, where was identified a problem situation: the institution's direction board reported to the students that they wouldn't have practical classes in that semester, even though the purpose of the course was that the disciplines occurred in the computer lab. With the intention to solve the problem, one of the teachers proposed to the students carrying out a work related to action research and active learning methodology. Through these strategies the professor mobilized the students to overcome the difficulties arose due to the lack of the computer lab. The project was well received by the students and executed successfully, thus favoring the satisfaction and permanence of the students in the institution.
- (2) Elisa Yumi Nakagawa, Kátia Romero Felizardo Scannavino, Sandra Camargo Pinto Ferraz Fabbri, and Fabiano Cutigi Ferrari in [8] provides a book with the objective to teach systematic review in the field of software engineering with a question and answer approach.
- (3) Jorge Biolchini, Paula Gomes Mian, Ana Candida Cruz Natali, and Guilherme Horta Travassos in [1] make a technical report in systematic review in Software Engineering. Such report was used to help the direction of review research of this paper.
- (4) Douglas A Carneiro, Gutemberg A Borges, Henderson S Chalegre, Jadson FJ Silva, Jéssica Magally J Santos, Lucas A Silva, in [2] discuss that difficulties to learn computer programming in Computing undergraduate programs contribute to high retention rates and an early dropout. The study proposes a solution to this issue through the use of programming learning environments that are more playful and entertaining. The results suggest an increase in student motivation and in the ease to learn central programming concepts. This approach is intended to be a adaptation of the current learning system. Although it proved to be a great approach to the problem, it is not enough to fulfill it's dimension. Our work propose a much wider approach.
- (5) Luísa Behrens Palmeira and Matheus Parreiras Santos in [9] make a data mining study on evasion rates in the Bachelor of Computer Science in University of Brasília. This study is the base of our context, it provides the problem in the course with a 55.76% dropout rate.
- (6) Barbara J Duch, Susan E Groh, and Deborah E Allen in [4] provides a book showing that problem-based learning is a powerful classroom process, which uses real world problems to motivate students to identify and apply research concepts and information, work collaboratively and communicate effectively. It is a strategy that promotes life-long habits of learning. Our work is based on the implementation of a problem-based learning to replace the traditional methods of learning

4 METHODOLOGY

The goal is the understand how the computer science students of University of Brasília, sees the active learning as a substitute for the traditional learning, in the aspects of learning rate improvements. The chosen methodology to investigate the proposed discussion was the survey, which in this paper was realized online, such that would be easier to distribute through the students.

4.1 Questionnaire

For the survey, were developed 13 question on a Likert Scale, that is a psychometric scale commonly involved in research that employs questionnaires. It is the most widely used approach to scaling responses in survey research, such that the term is often used interchangeably with rating scale. Finally, 5 subjective questions were developed so we could increase the understanding of the problem. The questions are in appendix A in Brazilian Portuguese, since that is the native language and not all people that do CS at UnB speak English.

3.2.2 Relevant Articles.

- (1) Barbara J Duch, Susan E Groh, and Deborah E Allen in [6] makes a study of the impact of systematic literature reviews which are the recommended EBSE method for aggregating evidence. The paper concludes that currently the topic areas covered by SLR's are limited.

4.2 Selection Criteria

The data collected using the online questionnaire need to remove outliers and data that does not correspond help answer the main question.

4.2.1 Inclusion Criteria. Partakes of the survey that are coursing or coursed Computer Science in the University of Brasília.

4.2.2 Exclusion Criteria. Partakers of the survey that did not have computer related classes and students that are in the first semester because they do not have much experience with the course yet.

5 RESULTS

The survey was distributed in the social media targeting Computer Science students in UnB. Since our survey was reasonable long we only got around 45% of the people that start the survey to finish. Gathering in the end of our research time 60 complete responses.

The responses came from different people and around 78% of them were part of our study group, Computer Science students. After cleaning the data from the students out of our study group and students from the first semester in the university, the data ended up with 46 valid responses.

First was analyzed the proportion of students of each semester who answered the survey. It was notable that most of our study group were related to students above it's fifth semester, as showed in the Figure 1. This information reinforce that our data with more experienced students might be a reliable source, since students from later in the course might have more experience than others.

After the study of the students position in the course progression, was analyzed the amount of students that ever had some experience with the active learning methodology. The data indicated that 23,91% never had done a course with the proposed methodology and 76,09% have had some experience.

With that information, the study were separated into two groups, those who already were a part of a active learning class, and those who were not. From this data, were extracted that people who had already done a subject using the proposed methodology tends to support the substitution of the traditional methodology, as seen in Figure 2.

Other relevant information extracted from the survey where:

- Most of the students completely agree that to be self-taught is an essential characteristic for a computer scientist, and most of them partially agree that they are capable of being self-taught.
- Most of the students partially agree that the teaching frequency of the Professor is different from the students learning rate, and they fell that their learning rate is different from others classmates.
- All of the students agrees that not every Professor is a good teacher as a researcher and vice versa, as can be noted in Figure 3.
- Most of the students partially agrees that computer science professors would be a better fit with the role of a tutor instead of a lecturer.
- Most of the students partially agrees that they are capable of making suggestions of improvements in the flaws or difficulties in the absorption of knowledge, and that they will

receive a good feedback if they would be capable to expose their learning.

- Most of the students completely agree that they have a facility in understanding when the content of the course is put into practice and that the lack of these is a hindrance on learning.
- Most of the students partially agree that they would like to be more encouraged to participate in class, even though the average of the students feels discouraged to participate in class with the fear of disturbing.
- Finally, most of the students partially agrees that the traditional lectures should be changed for discussion or practical classes.

With the subjective questions, were observed that most of the students feel that the traditional teaching methodology is full of flaws, that is an exceeded teaching system in which discourages students to learn, does not hold the student attention, and is a system that does not prepare the student for a job. A minority of students feel comfortable with the methodology, but knows it is not the ideal system for everybody.

Finally, most of the students believe that the traditional methodology should be changed to the active learning, but not everything. Most of them believe that there should be a balance between both methodologies, since they believe the change could not be effective in every course or for every person. A minority feels that the system should not change because some of the students would not adapt.

6 DISCUSSION ABOUT RESULT

Results showed that CS students at UnB prefer the active learning methodology. It is assumed that this results comes from the fact that our course focus a lot on the theory but lack practical classes. So many students end up not realizing that they do not know a certain subject until is too late. Using the proposed methodology, students will have more practical classes and could have more experience with the content they are learning. Learning a protocol does is different from understanding how is constructed of a protocol. Also, when a student practice what he was learned in class he can correct flaws of his understanding in a better way. It is also assumed that this will to substitute the methodology comes from the fact that the traditional methodology do not work well with students that learn at a very different rate. In class, the professor has the responsibility to teach for every student and struggle with students that already know the content and students that have difficulty learning the content.

In figure 3 the we can see that students do not think that the professors are well prepared to teach, they do no have a good pedagogical training. Passing the responsibility of learning to the student and teaching him how to study a subject, it is possible to overcome this problem. Professor would have to only guide the student in what to study and students would learn at their rate and learn a skill necessary to the market, the skill of self-teaching.

6.1 Threats to Validity

There are problems that could threat the validity of this experiment:

- Survey not done with a random set of people in the Computer Science population. Many of the responses come from people

that were doing the subject Experimental Computation with Edna Canedo.

- Results were based on one sample that could not represent the population.

7 CONCLUSION

Professors around the world are using active learning methodologies to improve learning. And there are some reports confirming that improvement. Therefore, we want to understand if there are interest from the students to apply this methodology in the course of CS at UnB.

The data collection was made by an online survey made in Brazilian Portuguese. We could extract 46 valid responses.

Analyzing the data we understood that students of Computer Science at University of Brasília have a tendency to prefer active learning to traditional methodology. And that there are problems in the way that professors teach, since students see them better as research tutors than really teachers.

Even though we find out that students want to change the methodology, we cannot recommend the change. Active learning methodology has many ways to be implemented. So the next step is to find which best suits for CS and its students at UnB.

ACKNOWLEDGMENTS

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Appendix A QUESTIONS

- (1) *Você já teve aulas de computação? (Linguagens, estruturas, padrões, protocolos, ...)*
- (2) *Qual seu curso? Ou qual foi seu curso?*
- (3) *Qual seu semestre?*
- (4) *Já participou de alguma matéria que aplicou a metodologia ativa?*
- (5) *Você acha que ser autodidata é uma habilidade essencial para um cientista da computação? Isto é, um profissional da área que não tem essa habilidade está muito atrás de quem tem.*
- (6) *Você acha que é capaz de ser autodidata? Isto é, consegue aprender certos conteúdos sem o auxílio de um professor.*
- (7) *Você acha que o ritmo de ensino dos professores, em geral, é diferente do seu? É relativamente comum eu ter a sensação que um professor é lento ou muito rápido durante suas aulas.*
- (8) *Você acha que o ritmo de aprendizado dos seus colegas, em geral, é diferente do seu? É relativamente comum colegas acharem que um professor é lento, enquanto você acha ele rápido e vice-versa.*
- (9) *Você acha que alguns dos professores do curso são melhores cientistas do que pedagogos? Isto é, alguns professores não tem um preparo pedagógico suficiente para ministrar suas aulas, mas são excelentes professores em relação a suas pesquisas e publicações.*
- (10) *Você acha que os professores de computação seriam ótimos tutores, ou seja, eles seriam capazes de guiar os estudantes na busca do conhecimento?*
- (11) *Você consegue identificar e efetuar sugestões de melhorias nas suas falhas e ou dificuldades na absorção do conhecimento e discutir com colegas e/ou professores sobre o assunto?*
- (12) *Você acha que ao expor o que entendeu para outras pessoas, pode receber um feedback sobre um entendimento, raciocínio e/ou conhecimento errado?*
- (13) *Você consegue compreender o conteúdo de maneira mais fácil quando as aulas são práticas?*
- (14) *Você acha que apenas aulas teóricas dificultam o aprendizado?*
- (15) *Você gostaria de ser incentivado a participar mais de algumas aulas? Isto é, gostaria de ter mais envolvimento para com o conteúdo passado em algumas aulas.*
- (16) *Você se sente desestimulado a participar das aulas? Isto é, tenho uma certa vergonha ou medo de atrapalhar a aula.*
- (17) *Você acha que a maior parte das aulas tradicionais poderiam ser trocadas por aulas de discussão, prática e/ou tutoria? O aluno deixando de ser passivo no aprendizado e tornar-se ativo.*
- (18) *O que você entende por ensino ativo?*
- (19) *Qual a sua opinião em relação ao ensino tradicional?*
- (20) *Você acha importante que o ensino tradicional seja trocado pelo ensino ativo? Isto é, o aluno ficar com a responsabilidade de aprender e o professor somente nos direcionar.*

Appendix B FIGURES

Proporção de alunos por semestre

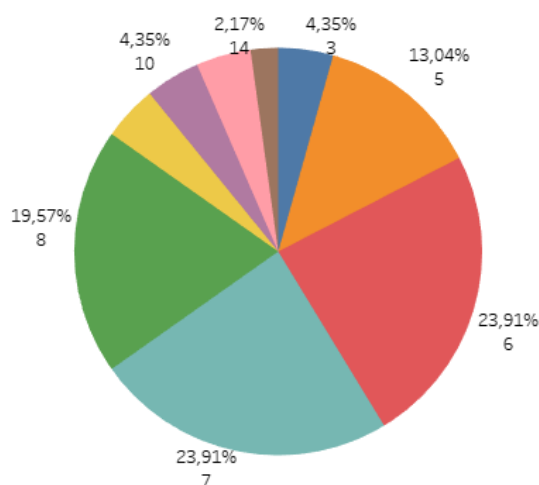


Figure 1: Proportion of students per semester who answered the survey

Você acha que a maior parte das aulas tradicionais poderiam ser trocadas por aulas de discussão, prática e/ou tutoria? O aluno deixando de ser passivo no aprendizado e tornar-se ativo.

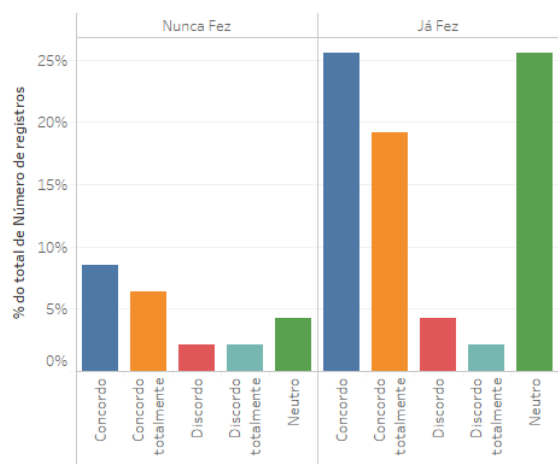


Figure 2: Graphic about the question "Do you think that lectures can be exchanged by discussion and tutoring classes?" separated by people who already had active learning classes and people who never had.

Você acha que alguns dos professores do curso são melhores cientistas do que pedagogos? Isto é, alguns professores não tem um preparo pedagógico suficiente para ministrar suas aulas, mas são excelentes professores em relação a suas pesquisas e publicações?

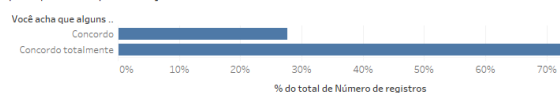


Figure 3: Graphic about the question "Do you think some professors are better scientists than pedagogues?".

Você acha que os professores de computação seriam ótimos tutores, ou seja, eles seriam capazes de guiar os estudantes na busca do conhecimento?

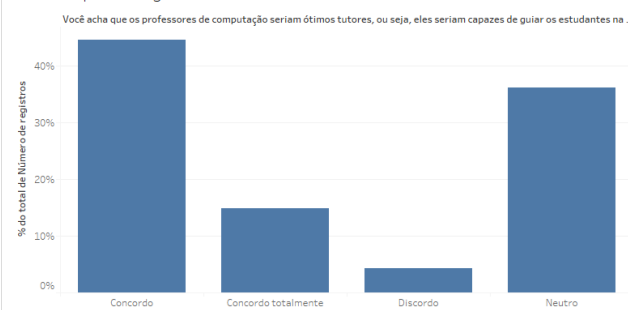


Figure 4: Graphic about the question "Do you think some professors are better to guide students in search for knowledge than teach them in classrooms?".

Você consegue compreender o conteúdo de maneira mais fácil quando as aulas são práticas?

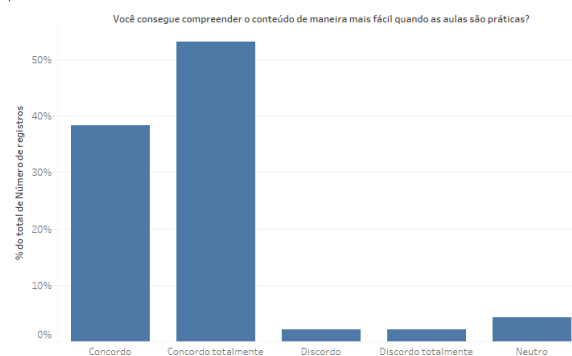


Figure 5: Graphic about the question "Do you learn the content of the course in an easier way when the class are more practical than theoretical?".

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