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Procedia Computer Science 221 (2023) 33–40

Procedia Computer Science

www.elsevier.com/locate/procedia

10th International Conference on Information Technology and Quantitative Management

Measurement of collaboration with agile practices in a Virtual Learning Environment

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Abstract

Virtual Learning Environments (VLE) are collaborative workspaces for teachers and students, such as Moodle and Google Classroom. However, in many VLEs with online classes, there is a perceived lack of collaboration and student engagement. The goal of our research is to identify the factors that facilitate or hinder collaboration in Google Classroom. The methodology adopted was a survey questionnaire, with 31 questions applied to Public Higher Education Institutions in the State of Rio de Janeiro, with 39 participants. Google Classroom proved to be a good collaborative tool e complies with Agile principles. The benchmark testing performed allowed us to identify the criteria that educators should pay more attention to throughout the courses.

Keywords: Agile management; Benchmark testing; Collaborative work; Computer Supported Cooperative Work (CSCW); Virtual Learning Environment (VLE)

1. Introduction

1.1. Background

Information technology has facilitated the daily activities of teachers and students in Computer Supported Cooperative Work (CSCW). Its proper use by educational institutions expands the skills and methods in obtaining knowledge of its users, from the introduction of tools that assist them, whether from smartphones, tablets or other

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1877-0509
10.1016/j.procs.2023.07.005

traditional resources [1][2]. In turn, Virtual Learning Environments (VLEs) are spaces that offer functionalities to aid online learning, either at a distance or in support of face-to-face teaching [3].

For [4] the application of agile methodologies to teaching and learning aids in the transfer of knowledge to acquired insight from shared collaboration and experience, in order to achieve common goals efficiently. In addition, these methodologies contribute to interaction between teams, reducing wasted resources, development time and effort. [5] present empirical evidence in the application of agile methodologies in the field of Education. Thus, along with other initiatives [6], [7], they demonstrate recent interests in educational resources.

Recently, there has been a great deal of interest in designing computer tools [8], mainly to help people work together more effectively [9]. Using terms such as "computer-supported cooperative work" and "groupware," these systems perform functions such as helping people collaborate on writing the same document, manage projects, track tasks, find, sort, and prioritize electronic messages [10].

1.2. Research problem

There are a few ways to assess collaboration. Even with the existence of tools that aid agile management, there are still few ways to do a quantitative assessment of collaboration. According to [11], some factors emphasize problems in collaboration such as: cancellation, layoffs, loss of outsourced human resources, problematic requirements, lack of training, and cultural differences, among others.

Thus, our goal is to verify the collaboration level of students using the Google Classroom VLE. A survey was conducted with students of the higher education network with the purpose of measuring the collaboration factor of the Google Classroom VLE.

This work is organized as follows: Section 2 presents the related works; Section 3 presents the methods and procedures adopted to develop the work; Section 4 presents and discusses the results obtained; Section 5 presents the final considerations about the work done.

2. Related work

Fuks et al. [12] present the 3C model, from the interaction among communication, coordination, and cooperation tools. Communication is related to the exchange of messages and information among people; coordination, in turn, is related to the management of people, their activities, and resources; and cooperation refers to the production that occurs in a shared workspace.

The 3C model explores the analysis and representation of an application domain (groupware), which will serve as the basis for the development of the collaborative system. The developer has a component-based infrastructure, designed exclusively for groupware, based on a collaboration model.

Clancy [13] presents a report that was used as a proof of concept. A study was conducted to validate the potential of the questions assigned to the respondents and how they worked with a particular tool. Then, some questions were proposed in order to identify: (1) specific jobs that are complex to perform with the tool; (2) understand how often the tool is being used for each job; (3) in which situations to get attention for usability improvement. Subsequently, the interviewees were sent two questions with the objective of evaluating the agreement on the following items: (1) the system is easy to use; (2) the system features meet personal needs. A Likert scale of 5 to 7 points was used and the metric used was related to user experience. To obtain the results, the users' answers were analyzed regarding the usability of a specific use case and whether they deviated from the overall average of the evaluations.

Parung and Bititci [14] provide a model to be used to define success in a collaborative network, from the contribution of the participants and their respective results. The research methodology was developed in three stages: Review, Construction, and Test. The Likert scale in turn was applied based on the main performance indicators, and an analytic mathematical approach was used to measure the contribution of the participants in the collaborative network. From the Analytic Hierarchy Process (AHP) decision tool, it was possible to demonstrate the value generation process and the evaluation factors of a collaborative network.

Arce et al. [15] propose an investigation work of the collaboration maturity level, based on the principles of the Agile Manifesto and Collaboration, from the application of a maturity model for the evaluation of collaboration in a real environment of application of agile practices. As a criterion for the evaluation methodology, descriptive research

was used, through data collection techniques, such as systematic observation. The results obtained in the evaluation had as a positive point the presentation of the evaluated team in its weaknesses and potentialities regarding the collaboration to maintain or improve performance. However, it has presented a tool, to apply the method semi-automatically as it is presented in this paper.

From a literature review, [4] assess the main agile methodologies that support education. The main trends of these methodologies in the teaching and learning context are identified. Students' progress in their activities was observed from motivation in an environment of trust with their respective teachers, becoming more effective with a collaborative effort. In turn, agile methods promote continuous project-based learning and knowledge transfer from the collaboration and experience of students and teachers.

3. Survey methodology

Our survey followed Kitchenham's steps [16]: setting the survey's objectives; designing the survey; developing the survey instrument; evaluating the survey instrument; obtaining valid data; and analyzing the collected data. The objectives were presented in the Introduction. The other steps are detailed below.

3.1. Research planning

The choice for conducting a survey-based study was based on the fact that it involves broad research, including participants from different academic institutions, and the study sample is composed of public higher education students. To support the elaboration of the questionnaire, Google Forms was used, which is a free tool produced for the creation of online questionnaires. The application of the questionnaire took place during the month of June 2022, from 06/02/2022 to 06/30/2022, in classes of the Higher Education network of the State of Rio de Janeiro, Brazil.

3.2. Development of the survey instrument

Based on the original work referenced by [12], 27 evaluation criteria were selected as the object of study, from the collaboration, coordination, and cooperation criterion [15]. Subsequently, 4 criteria were added, totaling 31 items [17]. The composition of the form to evaluate the collaboration of the classes was based on these 31 criteria that were adapted for application in a VLE.

The questionnaire was composed of closed questions and defined according to the Likert Scale, in which each participant of the survey specified the level of agreement in relation to a particular question or item investigated. These levels were classified according to the scale presented, as follows: 1- strongly disagree; 2- disagree; 3- neutral; 4- agree; and 5- strongly agree. Some questionnaire statements are shown in Table 1.

Table 1. Some questionnaire statements.

Constructor	Criteria	Survey statement
Cooperation	Goal	A common goal was pursued by the class.
	Geographical distribution	Distributed environments were used by the class.
	Shared task	Assignments were shared among the students.
	Resource	Available resources were used throughout the lessons.
	Commitment/Motivation	The motivation and commitment of the participants were encouraged.
Coordination	Monitoring tasks	Tasks were monitored.
	Problems solutions	Problems were solved efficiently.
	Tasks definition	The objectives and the tasks fulfilled by the class were well defined.
	Methodology	The methodology used was adequate.
	Coordinator role	There was a responsible person to remove impediments that arose throughout the learning.

Communication	Perception/Interpretation	The interpretation of the messages exchanged was efficient.
	Value	The value of learning was driven by student interaction.
	Information change	The exchange of information between the students was efficient.
	Communication language	The language between participants was appropriate.
	Knowledge sharing	Knowledge acquired individually was shared with the class.

3.3. Evaluation of the survey instrument

The survey questions were analyzed by 3 teachers that checked their statement and consistency with the 31 criteria. In turn, the goal of the survey was to evaluate the integration of the participants with the VLE and verify if the VLE was useful in the collaboration process.

Once the survey has been finished, the segment was defined and this data were provided to the Collaborizer software [18] so that the analyses can be generated. The application receives the CSV format file exported by the Google Forms platform. This data contains, in addition to the header with description, data about the time the questions were recorded and the answers. Once the data is available to the application, it performs aggregation and processing processes according to the type of information extraction desired. The processing aims to generate data visualizations in aggregate form in order to obtain interpretations of the total collected.

3.4. Obtaining valid data

This section presents the results of the questionnaire applied to higher education classes that use the Google Classroom VLE tool. Table 2 presents a summary of the main consolidated results.

Table 2. Higher education classes that use the Google Classroom VLE tool.

Institution	**Class**	**Valid answers**
UFRJ	English Language Training	11
UFRJ	Collaborative Systems	12
FAETERJ-RIO	Computer Science	9
Others	Others	7
Total		39

As classes in the mentioned context are of reduced size, the evaluated responses reflect this fact. The collected data represents a sample, being a percentage of the total.

Once collected, the data was analyzed. In preliminary results, the groups have shown a pattern with few changes between them. Some differences were centered in small quantities of scores and one criteria in each. As it was the focus to clearly obtain data from the Google Classroom, the study considered all these groups together. It provided a better number of answers based in the platform and educational level, higher education. These points, added to the fact were evaluated in a controlled and defined process, make it easier to reproduce and analyze these data for this context.

4. Analyzing the collected data

In order to develop the analysis, the acquired data is treated. The technical details of the data are presented in [18]. After this the data are evaluated based on the score each received. Lower or equal to 3 as being negative and equal or greater than 4 as a positive. This evaluation is then used in the subjective values given.

Some computational tools help to process and evaluate the collected data [19], [20]. The results of this survey are exposed through the use of the Collaborizer software [18]. It is possible to analyze the collaboration aspects present

in the analyzed target. The software allows us to visualize how the dynamics of the VLE performed in relation to each aspect, as presented in Fig. 1. It depicts the bar graph generated based on the average measured in each constructor.

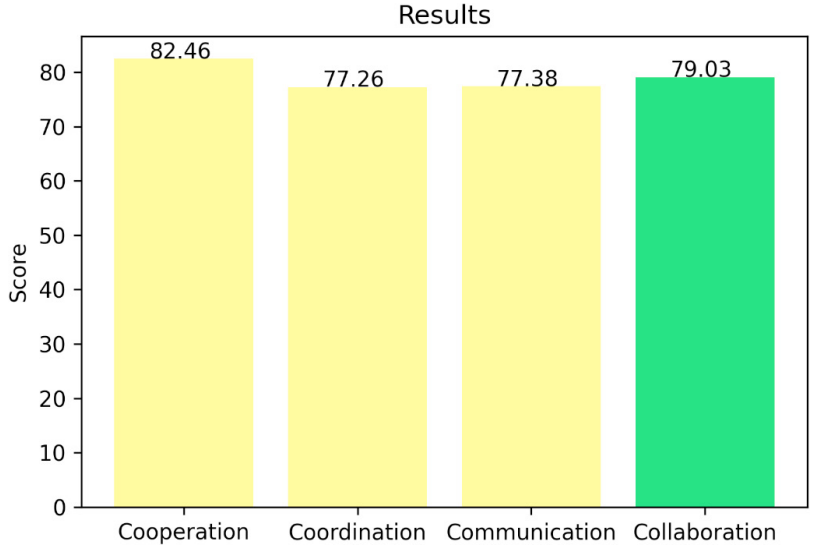

Fig. 1. Graph of the study sampling report.

The indicators from Fig. 1 can be understood following the considerations of Fuks et al. [12] and can be understood as: Cooperation is related to criteria of interaction, learning and sharing environment; Communication is relative to the interpretation and exchange of information among students; Coordination addresses the management and control of activities performed; and, finally, Collaboration is equivalent to average of the Cooperation, Communication and Coordination constructs.

In the sample obtained the Cooperation criterion stood out as the best, reaching 82.46, followed by Communication, with 77.38, and lastly Coordination with 77.26. With a total view, the Collaboration value is generated, obtaining a score that represents more generally. In the clipping, a high value of 79.03 was obtained, demonstrating up to this point, considerable success regarding collaboration. However, it is already possible to perceive some attention in relation to Coordination.

In order to understand the impacts on each criterion, it was generated a diverging stacked bar chart. It emphasizes the best and worst, based on the answers collected. The result generated by the tool can be seen in Fig. 2.

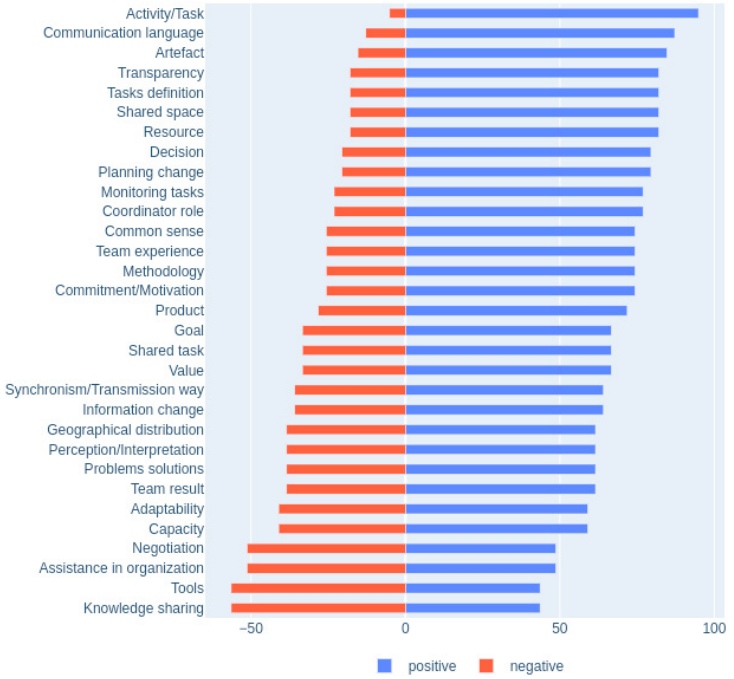

Fig. 2. Chart of the study sampling report.

As this graphic allows to highlight in a more detailed way the points of success and attention, some information can be deduced. The five best-rated criteria are: Activity, Communication Language, Artefact, Transparency, and Tasks Definition. Demonstrating a good environment that allowed the exchange of messages among the participants, generating a common space, where the tasks produced, as well as materials were made available. However, there are still the five worst ones: Capacity, Negotiation, Assistance in Organizational, Tools, and Knowledge Sharing. With these it is possible to see that extra supportive content such as extracurricular, organizing processes and content, enabling other knowledge, and process overview were not covered satisfactorily. Thus, the latter indicate possible changes to be made in what was attended to. In this way, one would achieve ways to improve the collaborative experience in the VLE.

Thus, it is possible to see that results were positive for the VLE and the cases observed. Although improvements should be made to enhance the collaboration process, overall, the requirements for Collaboration are satisfied. We observed that the Google Classroom VLE fails to organize the worked contents and provide a visualization of the learning progress. Furthermore, there are losses about other external learning, such as sharing the learning of those involved in the use of the VLE.

Given the results presented, we observed that in the criteria related to cooperation there is a common goal of the class, in addition to the organization of activities and the sharing of tasks among students. This is evident in the work presented by [10], in which a large number of initiatives have been observed to help people work together more effectively.

To summarize, we consider that the aspects related to cooperation, coordination, and communication are aligned with the learning process. Improvements will always be needed, and to have ways to measure and find where to act are important. In that way, this effort can indicate how collaboration can be improved, concerning specific elements and actions. Those, are connected to practices, methodologies, and tools.

5. Conclusion

In this paper a survey was presented that aimed to analyze the level of collaboration among students, from the VLE and the problems faced by students in their online courses. The results obtained show that the Google Classroom learning environment proved to be a good collaborative tool for higher students.

Collaborizer has identified the weaknesses of collaborative work and promotes the improvement of teams and technological resources. It, also, has put into practice a new approach of the evaluation method, using a developed tool, providing an semi-automatic process.

This work is restricted to results from the survey of participants through the display of objectively pre-selected options. There was no analysis of open and exploratory answers.

In future work, we intend to investigate factors that negatively affect collaborative work, as they can provide aspects that could be discounted in the benchmarking calculation. Another possibility consists of evaluating other collaborative tools and generating rankings.

Acknowledgements

The authors of this publication recognize the “Universidade Federal do Rio de Janeiro” (UFRJ) and the “Coordenação de Aperfeiçoamento de Pessoal de Nível Superior” (CAPES) for their support on the development of new technologies.

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