Undefined Socio-Affective Scenarios in a Virtual Learning Environment

A View from Learning Analytics

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Abstract—There is a growing number of virtual courses being offered by Brazilian educational institutions, requiring the development of technological resources and research to assist in the teaching and learning processes in Distance Education (DE). The analysis of the students' socio-affective profiles in Virtual Learning Environments (VLE) enables possibilities to develop methodologies and/or resources to better understand them. The Social Map (SM) and Affective Map (AM), both features of the Cooperative Learning Network (ROODA in Portuguese), provide inferences and graphic presentations of students' socio-affective profiles. Thus, this article aims to identify students with Undefined Socio-affective Scenarios in a VLE, based on Learning Analytics (LA). LA is defined as the measurement, collection, and analysis of data. This qualitative and quantitative research approach was carried out based on 10 case studies. The target audience was divided between 77 undergraduate students, 29 graduate students, 27 elderly people, and 86 professors who participated in teaching activities at a Brazilian public university. Data collected from the SM and AM were extracted in order to identify the relationship between these two aspects. The result was 18 Socio-affective Scenarios using LA and the identification of 108 Pedagogical Strategies to contribute to the analysis of students' learning profiles.

Keywords—learning analytics, socio-affective scenarios, virtual learning environments

1 Introduction

Distance Education (DE) has transformed over the past ten years, and consequently, virtual course offerings have increased in order to make education available throughout Brazil [1]. This modality brings the flexibility of time and place to study but makes physical interaction between the parties involved in the teaching and learning process more difficult. In fact, there are great challenges when it comes to following each

student's distance learning trajectory. It is therefore necessary to develop and employ different strategies to increase students' DE success rates [2].

By valuing more comprehensive studies, educators can make important moves to explore social and affective dimensions. This study understands the construction of knowledge based on the work of Piaget [3, 4], in which social exchanges and affectivity play specific and vital roles for both teaching and learning. From the Piagetian perspective, social interactions form a link between the subject-environment and, thus, foster discussions about the learning object, causing new cognitive structures to be built. On the other hand, affect is linked to the motivation to discover, awakening an interest in research, acting as the driving force behind the individual's actions [4].

Thus, according to Dolle [5], the subject learns not only by internal affective and cognitive processes, but especially by the demands caused by their social relationships. In fact, the relationships established between professor, student, object of knowledge, and the environment represent essential aspects in teaching and learning. These exchanges train individuals beyond the construction of knowledge, such as living in society. The affective and social attributes are inherent, deeply conditioning cognitive processes [4, 6].

Therefore, although tools are constantly improving and consequently positively affecting distance learning, many issues remain in this teaching modality, such as the recognition of students' affective manifestations and the interactions that emerge (or not) in these spaces. Thus, if professors were provided with this information, they would have essential elements to meet the demands of their students by offering them adequate help [7].

Understanding the interests and particularities of the students and bringing the actors involved closer together would enhance the relationships that occur in the teaching and learning processes. In fact, the Learning Analytics (LA) research area emerged in 2010 as a solution to address this new need to analyze the interactions carried out in these spaces. It is based on web analytics and initially emerged to serve only students facing difficulties. However, it is currently used to monitor all students' trajectories, allowing for individualized analysis [8, 9], yet studies using LA in the Brazilian context in Virtual Learning Environments (VLE) are recent and scarce [10].

Given this panorama, the study that underlies this article starts with a reflection on the social and affective aspects in a VLE. The objective of the research presented in this article is to identify the possible recurrent Undefined Socio-affective Scenarios, based on LA, in the Cooperative Learning Network (ROODA in Portuguese) VLE and propose Pedagogical Strategies (PSs) to support teaching actions in this context. Scenarios are understood here as the mapping between the indicators of the Affective Map (AM) and the Social Map (SM) presented in ROODA. The AM addresses personality and behavioral factors to infer and recognize what the learner's mood may be: Animated, Discouraged, Satisfied and Dissatisfied. The SM maps and presents information regarding the student's interactions obtained in a VLE in a graph. In turn, the social interactions detected by the SM refer to the indicators: Absence, Collaboration, Feeling separate from the class, Drop out, Informal Groups, and Popularity. Only some of these indicators occur simultaneously. Thus, Scenarios are composed of combinations of the student's affective state inferred by the AM and the student's social interaction

indicators detected by the SM. A Scenario therefore represents one or more occurrences of a given affective state with distinct variations of social interactions.

This paper presents the process of mapping Undefined Socio-affective Scenarios and the elaboration of PSs to specifically address each. Based on the strategies developed and recommended, a professor can apply educational practices appropriate to this situation and make decisions based on the needs and interests of students with Undefined profiles. Thus, this article is organized into seven sections. The following section discusses the ROODA VLE as well as the social and AMs. The third section discusses LA. The fourth section describes the concept of PSs. The research methodology is presented in the fifth section. The sixth section presents the results that were obtained. Finally, conclusions are offered.

2 The ROODA virtual learning environment: A focus on affective and social maps

The Cooperative Learning Network VLE (ROODA), is user-centered and enables access to materials and tools as well as spaces for exchanging and sending activities with the aim of providing a place for interaction between its participants. Thus, because it is an environment used by the university, it is constantly being updated in order to keep up with changes in the academic community [11].

Research for this article was done in ROODA, because the VLE was adopted for teaching activities for undergraduate, graduate, and extension courses. ROODA has a total of 26 communication features (synchronous and asynchronous), in addition to the SM and the AM—the latter two are used to identify students' social and affective interactions. The SM and AM are used exclusively by the teacher to graphically display the aspects of the students participating in ROODA. Data are obtained from communication resources such as the logbook, forum, contacts (similar to email), and chat, in addition to comments inserted in the web portfolio and the library [11, 12].

The AM graphically presents the student's mood, which can be Animated, Discouraged, Satisfied, or Dissatisfied, through the analysis of their performance in the environment. A description of the four moods in the AM as defined by Longhi [12] are: Satisfied indicates that the student reveals joy, enthusiasm, satisfaction, and pride in accomplishing the task; Animated shows that the student somehow demonstrates within the affective family of hope, interest, calm, and surprise when facing learning challenges; Discouraged suggests that the student somehow demonstrates or represses the expression of guilt, fear, shame, or sadness for not being able to follow the content, and Dissatisfied expresses or tries not to show irritation, contempt, aversion, and envy. Aggressiveness is often noted, and the student may encourage reprisal or revenge.

The SM tool aims to present the social relationships formed in the environment, making it possible to identify the interactions of the participating subjects in the form of sociograms. It is possible to perceive the social position of each participant and their relationship with the rest of the group. The indicators of social interaction enable the visualization of bonds, influences, and preferences that exist in a certain discipline or in a group [11]. Thus, from the SM, the social indicator degree is calculated, which can

be: Absence, Collaboration, Feelings of separation from the class, Drop out, Informal Groups, and Popularity. Absence: the subject enters the VLE and does not go back to respond to requests from the class (professors, teaching assistants, or students); Collaboration: the user contributes by sharing files, content, images, pages, and links; Feelings of separation from the class: the student sends messages and publishes in the VLE but does not receive feedback from peers; Drop out: this person never accesses the teaching activity (subjects or courses) in question and has not established any exchanges; Informal Groups: the student has exchanged messages between three or more subjects, thus verifying the existence of groups among the participants; and Popularity: the user maintains a higher frequency of interactions in relation to the rest of the class, based on an average among all students, highlighting those who are above average [7].

Thus, both the AM and the SM can assist educators in their virtual pedagogical practices by pointing out the students' profile in a simple graphic way. In the next section, the concept of LA, the reference model, and the general foundational process of this work are explained.

3 Learning analytics

LA emerged as a solution to address the need to enhance the relationships that occur through technology in the teaching and learning processes. In addition to understanding students' interests and needs, it is particularly suited to address students that have difficulties building knowledge [8, 13].

Thus, LA is defined as the measurement, collection, analysis, and reporting of data about students and their learning contexts. Therefore, its focus is to bring together the actors involved and analyze the interactions carried out by students in virtual spaces [14]. Based on a multidisciplinary investigation, Chatti et al. [14] designed a reference model based on four dimensions, which are: what, why, how and who. "What" refers to the types of data collected. These can come from VLE, instructional sources, social networks, among others. "Why" is related to the goals and results of the analysis carried out, which may be: monitoring and analysis, prediction and intervention, tutoring and monitoring, evaluation and feedback, adaptation, reflection, personalization and recommendation. "How" is linked to the different techniques that can be used to detect patterns contained in the data. "Who" is aimed at the public involved, which may be students, professors, educational institutions, researchers, system designers, among others.

In this study, the data collected all came from the ROODA VLE, the goals and results were monitoring, analysis, and personalization. The technique used was manual mapping of the indicators and the target audience was professors and students.

In this context, we emphasize the importance of LA in terms of understanding and optimizing learning, following the students' path, allowing specific and individualized analysis and, thus, considering the LA reference model as well as the indicators mapped in the SM and AM. The concept of PSs is presented below.

4 Pedagogical strategies

PSs are a set of actions planned and implemented by the professor in their educational practice in order to achieve the desired objectives to develop their students. PSs can be suggestions for the use of digital technologies, complementary activities, collective construction of texts, and recommendations for task completion. Using a PS can instigate the interactions as well as the synchronous and asynchronous communications available in a VLE, promoting student dialogue, collaboration, cooperation, active participation, and autonomy [15].

According to Amaral [15], constructing a PS should begin with the analysis of the class profile, i.e., finding out about the students in the DE. Different techniques can be used to do so, such as observing social interactions, applying questionnaires, among others. The creation of a PS requires constant reflection and awareness of the intended goal. Every time the professor elaborates ways to achieve a purpose and establishes actions in the educational process, they are weaving a PS. The author emphasizes the importance of the strategy considering the student's previous development and context, especially the social and affective aspects they have experienced. Thus, only by observing these behaviors can the professor act in a personalized way and design more pertinent PS, contemplating the individual needs of each student.

Moreover, the authors Barvinski et al. [16] establish criteria for a PS to be considered adequate in terms of structure, language, and direction of actions. Action: point out the action to be taken by the professor or teaching assistant; Resources: indicate the resources that can be used to carry out the action (in this research they are: chat, library, contacts, logbook, forum, and web portfolio_; Direct Language: use direct language, subjects are the professor or teaching assistant; and Self-evaluation: suggest that the professor perform a self-evaluation of their pedagogical procedure, verifying the points of their practice that contribute to the student's Socio-affective position (if positive) or restructure the activities and content in order to attempt to remedy the student's negative experience.

Thus, based on these four criteria, the present study developed PS for each Undefined Socio-affective Scenario, incorporating the use of the six features in the ROODA VLE that act as indicators of the Affective and SMs. The methodology employed is presented in the following section.

5 Methodology

The research presented in this paper aims to identify the recurring Undefined Socio-affective Scenarios, from LA in a VLE. Thus, a qualitative and quantitative approach was applied, such as multiple case studies, which, according to Yin [17], allow for comparisons of a contemporary phenomenon within context. The target audience included those in undergraduate, graduate, and extension courses offered at a Public University of Brazil. Thus, ten case studies were carried out that made it possible to apply LA and meet the research objective.

In this context, data collection took place from the interaction and technological production in ROODA, during the period from first semester of 2019 to first semester of 2020 in ten teaching activities (eight subjects and five courses) totaling 285 students, according to Table 1.

Table 1. Mapping case studies

Case Study	Learning Activity	Modality	Period	Number of Weeks	Number of Students
1	Graduate A	Hybrid	1st semester 2019	17	16
2	Graduate B	In person class	1st semester 2019	17	16
3	Graduate A	Hybrid	2nd semester 2019	17	10
4	Graduate B	In person class	2nd semester 2019	17	21
5	Graduate A	Distance Education	1st semester 2020	16	14
6	Graduate C	Distance Education	1st semester 2020	15	15
7	Undergraduate A	Distance Education	1st semester 2020	16	23
8	Undergraduate B	Distance Education	1st semester 2020	15	6
9	Course A	Distance Education	1st semester 2020	6	27
10	Course B	Distance Education	1st semester 2020	17	48
11	Course C	Distance Education	1st semester 2020	6	38
12	Course D	Distance Education	1st semester 2020	18	33
13	Course E	Distance Education	1st semester 2020	7	18
Total students					285

The undergraduate and graduate courses were offered at a Brazilian Public University between 2019 and 2020, 121 students participated. The DE courses took place in 2020; a total of 164 subjects (81 elderly and 83 professors) had their data analyzed. It is important to mention that, in the first semester of 2020, it was possible to carry out 9 case studies due to the COVID-19 pandemic, which extended the school term to the whole year.

Only the students' activities were analyzed, but the professors' teaching activities were not. There were no instructions for the teachers, they taught their classes as they had previously been planned. The researchers accessed the student data and mapped the scenarios.

Thus, from the analysis of the 13 case studies, a spreadsheet was created to identify the scenarios that arose in the AM and the SM. It then became possible to map the Socio-affective Scenarios of the students and the class. Finally, the spreadsheet was refined by accounting for recurrences. Hence, 56 Socio-affective Scenarios were created. Scenarios that did not contemplate the social and affective indicators that were identified were labeled as Undefined. Subsequently, the Undefined Scenarios were selected because they were those that appeared the greatest number of times in the 13 case studies. Thus, an analysis of the Undefined Scenarios was carried out in order to understand why most students were in this category and to, therefore, build PSs capable of intervening in these cases.

Based on these considerations, the next section presents the results obtained.

6 Results

It should be noted that a student can only be present in one affective indicator in a given week. Within this period, based on variations in mood that do occur, the students' position in the AM is determined. On the other hand, the student can be in more than one social indicator during a week, because the quantity of interactions is counted by counting the exchange of messages, as well as the frequency, sending, and sharing of files. Thus, if the student performs more than one action in ROODA, he or she may have more than one indicator.

However, in the mapping between social and affective indicators, 56 Socio-affective Scenarios were identified, yet 18 of them had none of the indicators (social or affective) that were analyzed in this study. Thus, the objective of this work is to identify the Undefined Scenarios, whether social or affective, as well as to create PS for these Scenarios.

Undefined Affective and Undefined Social Scenarios were created specifically for this purpose. Undefined Affective corresponds to the subject that is not present in any of the four quadrants (Animated, Discouraged, Satisfied, and Dissatisfied) in a given week. The reasons found for the student not being identified in any of the four moods were: the teacher's pedagogical practice did not request the use of the tools that extract data for the generation of the AM (chat, logbook, and forum) or they did not use these tools that week, thus making it impossible to determine students' affective indicators. On the other hand, Undefined Social refers to the individual who, despite being present in the VLE, did not report Feeling separated from the class or Drop out. However, this student nonetheless did not appear in any other social indicator: the student was not collaborative, did not belong to any informal group, and was not popular. This can occur when the student enters the VLE and does not write using any of the communication tools or has minimal participation, not allowing for collection or categorization of any of the indicators. The "Undefined Affective" Scenario is in the AM; therefore, it was simply readapted for the context of this research.

The result of the mapping between the affective and social indicators was organized in order to present the Scenarios that were found in this research, as can be seen in Table 2. The first column names the combinations, abbreviated by the letter "S" and a sequential number. The second column is composed of the affective indicators, being: Undefined Affective, Animated, Satisfied, Dissatisfied, and Discouraged. The third is composed of the social indicators and the creation of the Undefined Social. Finally, in the last column are the number of times that each Scenario appeared in the 13 case studies analyzed.

Table 2. Mapping socio-affective scenarios

Socio-Affective Scenario	Affective Indicator	Social Indicator			Number of Times
S1	Undefined Affective	Absence	–	–	715
S2	Undefined Affective	Collaboration	–	–	264
S3	Undefined Affective	Feeling separated from the class	–	–	5
S4	Undefined Affective	Drop out	–	–	364
S5	Undefined Affective	Popularity	–	–	8
S6	Undefined Affective	Undefined Social	–	–	1011
S7	Undefined Affective	Absence	Collaboration	–	229
S8	Undefined Affective	Absence	Informal Groups	–	1
S9	Undefined Affective	Collaboration	Feeling separated from the class	–	7
S10	Undefined Affective	Collaboration	Informal Groups	–	1
S11	Undefined Affective	Collaboration	Popularity	–	19
S12	Undefined Affective	Informal Groups	Popularity	–	14
S13	Undefined Affective	Absence	Collaboration	Informal Groups	1
S14	Undefined Affective	Collaboration	Informal Groups	Popularity	26
S15	Satisfied	Undefined Social	–	–	129
S16	Animated	Undefined Social	–	–	124
S17	Discouraged	Undefined Social	–	–	42
S18	Dissatisfied	Undefined Social	–	–	16

An analysis of Table 2 shows that three combinations frequently occur. They are: "Undefined Affective and Undefined Social" (n = 1011), "Undefined Affective and Absence" (n = 715), and "Undefined Affective and Drop out" (n = 364). Thus, the importance of creating these two new indicators stands out, since the Scenario with the highest recurrence was precisely "Undefined Affective and Undefined Social." It is important to highlight that the identification of "Undefined," both social and affective, is fundamental for these subjects and their particular interactions to be included in the VLE.

Therefore, based on the 18 mapped Scenarios, a PS was created for each of the six features in the ROODA VLE (chat, library, contacts, logbook, forum, and web portfolio), for a total of 84 PSs. These were constructed by a group composed of 15 professors specialized in DE with graduate training and experience in ROODA. It was also developed using the criteria established by Barvinski et al. [16], in order for the PS to be considered adequate in terms of structure, language, and direction of actions.

The creation process required 8 weeks of work, starting on 06/22/2021 and ending on 08/10/2021. During this period, 5 meetings took place in a synchronous video conference platform, in which the participants brought doubts, questions, observations, and reports about the strategies. The 108 PSs were divided among the 15 professors, totaling 7 for each, with one of the specialists contributing 3 more due to arithmetic issues related to the division of the tasks among the team members.

An online spreadsheet was made available, shared in edit mode with all participants. It contained 7 columns, as follows:

Description of the indicator: In this field, the meaning of the indicator was written, for example: "This indicator refers to the student with a very specific profile, since it was not possible to identify his mood in the VLE, that is, they are neither Animated nor Discouraged, neither Satisfied nor Dissatisfied."

Variables: Correspond to the features, which are: chat, library, contacts, logbook, forum, and web portfolio.

If (affective indicator) and (social indicator) and (feature) and (age value): This column contained the conditional "if" command, called "proposition logic" or "if then," which is a truth table, in which combinations were created. In the case of the first strategy, this field looked as follows: If (Undefined Affective) and (Absence) and (chat) and (A≤59), then strategy UAAc1 is recommended.

Identifier PS: This is the abbreviation of the initials of the affective indicator, social indicator, feature, and strategy number, for example: Undefined Affective, Absence, chat, and strategy number 1, thus: UAAc1.

PS based on the Socio-affective Scenario: This field should be filled in by the specialist with the description of the PS.

Name: In this column, each person put their name based on the PS they wanted to develop.

Status: This space was for the professor to fill in the status of the strategy—for example, they could put "ok" if it was finished or "to do" if it was not ready. After the spreadsheet was made available, the participants developed the PSs individually based on the Socio-affective Scenarios. Each expert was responsible for developing their total number of strategies, which dispensed with the need to establish weekly production goals or corresponding follow-up.

Table 3 shows examples of the PSs that were created for the "Undefined Affective and Undefined Social" Scenario.

Table 3. Pedagogical strategies created for the undefined affective and undefined social scenario

If (Undefined Affective) and (Undefined Social) and (chat) and (A≤59), then strategy UAUSc6 is recommended. The student has an Undefined Affective status and Undefined Social interactions. In the first case, the student shows neither (in)satisfaction or animation or lack thereof and also does not interact in the VLE. The lack, or low social interaction, was one of the aggravating factors that interfered in the affective and social data of this subject. Due to the lack of messages sent and received in the environment, it was not possible to identify their mood or social indicator. Therefore, it is important that the student is contacted to analyze what difficulties and challenges they are facing. The chat feature enables synchronous communication and sharing of materials. Therefore, you can contact the subject through chat and encourage them to participate in the VLE. You can also ask them about their perceptions of the assignments, the teaching activity, the difficulties as well as the challenges they have faced. Positive feedback to this student can make them feel closer to you and more comfortable sharing their feelings. Hence, it is also important to evaluate the process and make changes if you consider them to be necessary.
If (Undefined Affective) and (Undefined Social) and (library) and (A≤59), then strategy UAUSl6 is recommended. The student has an Undefined Affective status and social interactions. They show neither (in)satisfaction, animation, or lack thereof and also have not interacted in the VLE. The lack or low social interaction was one of the aggravating factors that interfered in the affective and social data of this subject. Due to the lack of messages sent and received in the environment, it was not possible to identify the mood or social indicator of this student. Therefore, it is important that you contact them and analyze what difficulties and challenges they are facing. The library feature allows you to publish, organize materials, and links as well as interact through comments. Hence, send a message through contacts to ask the student to select a video about the topic you are working on and post it in the library. Then, make a comment about the video ending with a question. The idea is that you create a way to contact the subject and in this first communication also ask them to share the link of this video through contacts with the class and to write how they felt doing this activity in their logbook. The goal is that, after the initial exchange with this student, it is possible to identify their mood and social interaction. This is a very interesting and challenging strategy; however, it is pertinent that you do a self-evaluation about your role and the importance of the words used during the process, since an incorrect mediation can lead the student to give up and even drop out of the class.
If (Undefined Affective) and (Undefined Social) and (contacts) and (A≤59), then strategy UAUSco6 is recommended. The student has an Undefined Affective status and social interactions. The subject shows neither (in)satisfaction, animation, or lack thereof and also does not interact in the VLE. The lack, or low social interaction, was one of the aggravating factors that interfered in the affective and social data of this subject. Due to the lack of messages sent and received in the environment, it was not possible to identify their mood or social indicator. Therefore, it is important that you contact this student and analyze what difficulties and challenges they are facing. The contacts feature allows you to directly approach this student. You can send a private message, encouraging them to interact and highlight the importance of this contribution to their learning process and to the teaching and learning process of the class. In addition, you can ask the subject to send messages to their classmates on general topics. Next, encourage them to write in their logbook about how they felt about the proposed activity. The goal is to identify their mood and social interaction. Thus, it is important that you carry out a self-evaluation of the strategy applied, in order to analyze if it is adequate for the student's profile and context.

The same process occurred for all 108 PSs based on the Socio-affective Scenarios, which are available at the link: https://drive.google.com/file/d/1KerUrh7MsZMOXchD_XU3nyl5tmj_hxI/view?usp=sharing. The PSs are in Brazilian Portuguese, because this study was applied specifically in this country.

Therefore, the Socio-affective Scenarios found may or may not be repeated in other situations, depending on pedagogical practices, the communication tools adopted, and the student's profile. The main contribution of this work is to point out the existence of certain Scenarios that can be inferred and PS that can be applied. From this information, professors can decide how to act, when trying to intervene in a Scenario such as Undefined Affect and Drop out.

7 Conclusions

In DE, the physical distance between the actors in the educational process makes their relationships unique. Therefore, the ways of knowing the other, communicating, and acting in a VLE are elements of analysis for the continuous qualification of this teaching modality. Thus, given its particularities, it is also necessary to consider the relevance social and affective processes play in learning. It is also necessary to develop analytical tools to give the VLE new resources that have the potential to promote pedagogical practices that are more sensitive to the DE paradigm.

Hence, it is advantageous for the professor to master these new tools and understand the student's socio-affective profile. By meeting their individual interests and needs, the goal is to contribute with the provision of subsidies for professor to reflect on their actions in teaching and learning processes and in decision-making.

In this study, 18 Socio-affective Scenarios were identified and 108 PSs were created, which are available for manual use by professors. Future research possibilities are related to the development of tools that analyze each student and automatically recommend PS. Thus, we intend to support interactions and professor mediations in VLEs as well as to contribute to the process of teaching and learning in DE.

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