Method for Evaluation and Classification of Self and Co-regulation of Learning in Immersive Narratives

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Abstract. Self and co-regulation of learning (SCRL) are strategies that students can adopt to become more active and committed to their learning. Encouraging students to adopt these strategies is a challenge for teachers that can be met by using narratives as a teaching resource. To support teachers in this process, we present a method for evaluating, classifying, and reflecting on excerpts from immersive narratives for SCRL, so that you can objectively base your decision when applying the method. The method was developed as an artifact of Design Science Research (DSR). In the Design stage of DSR, a 4-stage scheme was developed, and 38 criteria were described to identify and classify narratives that guide or encourage students to adopt SCRL strategies. In the DSR demonstration stage, we tested the method in an asynchronous e-learning curricular unit (UC) in Portuguese higher education, which uses a narrative-oriented immersive learning approach for SCRL, called e-Sim(Programming). The results show that the graphic visualization of the classification made it possible to perceive the occurrence of the SCRL categories in the narratives, enabling the teacher to be inspired and reflect on the categories to be enhanced for necessary changes in the narrative in line with their pedagogical objectives.

Keywords: Method, Narratives, Criteria, Self-Regulation and Co-regulation of Learning.

1 Introduction

Narratives are a version of reality [1] and a fundamental element in the phenomenon of immersion, which emerges from the combination of the feeling of presence in a diegetic space, the focus on carrying out activities and the psycho-logical absorption by the narrative [2]. Immersion emerges from the properties of the system (technical, human or organizational) used to promote this cognitive state and from the possibilities of the

individual's agency and their reaction to the narrative [2, 3]. Immersive narratives make it possible to immerse the target audience, creating situations and approaches to promote deep mental involvement to the point where the audience's state of attention becomes dissociated from reality [4]. Immersive learning [4] as a learning phenomenon when associated with the psychological state of immersion (e.g., immersion by the narrative plot that may involve characters, scenarios, among other elements, to develop classroom activities), has been explored in Immersive Narratives to foster Self-regulation of learning (SRL) and Co-regulation of learning (CRL) in online higher education in Software Engineering courses [5–7]. SRL is made up of a set of strategies that can be adopted by students so that they can be active in their learning process [8–10]. However, in group work, there is a need for strategies from the perspective of the group for CRL [8, 11, 12] . No methods for evaluating, classifying or creating immersive narratives for SRL and CRL were found in the literature [13], to solve this problem, a method was developed as an artifact of DSR for designing narratives for SCRL and Narrative Immersion, consisting of two steps. The first focuses on designing narratives to foster SCRL, whose classification and evaluation steps for this design will be communicated in this work, and the second focuses on evaluating, classifying and designing immersion dimensions in narratives [14]. The aim of this work is to present a Method for Evaluation, Classification of SRL and CRL in Immersive Narratives to support teachers in designing immersive narratives as teaching resources. We applied the method to an asynchronous e-learning course in Portuguese higher education, which uses a narrative-driven immersive learning approach [5] for SRL and CRL called e-Sim(Programming) [6]. The results show that it is possible to perceive the occurrence of the SRL and CRL categories in the narratives used. This classification's graphic visualization allows the teacher to be inspired and reflect on the categories to be potentialized in line with their pedagogical goals.

2 Background

2.1 Immersive Narratives

Immersion is "a cognitive state in which individuals are engrossed, i.e. deeply mentally involved, to the point where their attention begins to dissociate from the rest of the world" [4]. It emerges from the properties of the system (technical, human, organizational), which can be influenced by it to bring about this cognitive state, the possibilities of the individual's agency and the reaction to the narrative [2, 3]. An immersive narrative should promote the narrative immersion of the target audience, regardless of the technology used to convey the story [13]. Narrative immersion is a feeling of being inside a story, with a deep involvement for which the world and the events of the story are accepted as real [15]. Nilsson show [2] there are different perspectives on narrative immersion, they can all be integrated into the three dimensions of narrative immersion proposed by Ryan [16] (e.g. spatial immersion, a strong sense of place and the pleasure of exploring this diegetic space; temporal immersion, the desire to know what is going to happen and the connection to diegetic time; emotional immersion, the concern that arises from the emotional connection to the characters). Twenty techniques for

designing immersive narratives were grouped into Ryan's 3 dimensions [16] increasing the range of possibilities for designing immersive narratives to encourage the adoption of SCRL strategy categories.

2.2 Self and Co-regulation of Learning

SRL is characterized by the degree of involvement or active participation of the student in the learning process, at the metacognitive, motivational and behavioral levels [10]. Self-regulated learning is a central conceptual framework needed to understand the cognitive, motivational and emotional aspects of learning [8]. In Zimmerman's SRL triad model [17], feedback from the environment (teacher) to the person (student) can alter their behaviour to adopt self-regulation strategies (organization, monitoring, etc.), increasing intrinsic self-regulation or "hidden self-regulation", to achieve their learning goals. Zimmerman [18] isolated 15 categories of SRL by comparing the self-regulation statements of each student and the perception of teachers in relation to each of them. Pedrosa [6] when applying Zimmerman's categories to a Software Engineering Project course using narratives for SCRL, adapted and dismembered the categories that aggregated different activities (e.g. organization and transformation; goal setting and planning); added the category "structuring the psychological environment" to isolate external interferences. These adaptations led to 17 SRL categories. While SRL focuses on the student's active learning, CRL enables the teacher to perceive the student's learning in group work contexts, in which one member of the group takes the lead in regulating learning [8]. CoRL is reported in three forms that are most agreed upon by the authors [12]: 1. help from external agents (teachers, classmates, materials, etc.), to regulate metacognitive and motivational aspects of the student; 2. transition in the acquisition of regulation where the management of co-regulation can alternate between the actors (regulating agents and students); 3. There is an interdependence between the regulation processes, this being a bidirectional process in which one influences the other (positively or negatively). Pedrosa [7] adapted the SCRL strategies [6, 18] into 17 CRL categories making it possible to isolate and deepen the application of CRL. Tsai [19] applied a method combining Design Thinking and Web-mediated Co-Regulated Learning to develop computer skills in semi-presential higher education students. However, the development of SCRL strategies by the student has been a challenge for teachers for many decades [18].

2.3 Use of Narratives for Self and Co-regulation of Learning

A study in higher education in Spain and Portugal, with 84 and 88 students respectively, used fictitious letters as a narrative from a first-year university student, in which each letter applied SRL strategies as an opportunity to teach and improve students' deep learning approaches and their SRL processes. The effectiveness of the program in promoting self-regulation in higher education students was proven in both cases [20]. Immersive narratives have been used to simulate an environment of a Fictitious Company (SimProgramming) of Software Engineering and promote immersion in course of

online Higher Education in Portugal, with good results in the adoption of perceived SCRL strategies [5] and was used for application that supports this co-communication.

3 Methodology

This work presents a solution to the following problem: How to evaluate and classify narratives for Self and Co-regulation of Learning? We used as a strategy the development of a Method for Evaluation and Classification of Self and Co-regulation of Learning in Immersive Narratives, presented in section 4, as an artifact of Design Science Research – DSR [21, 22]. The aim of the method is to support teachers in applying SCRL strategies to narratives as a teaching resource. We carried out cyclical iterations of the Design Science Research Methodology - DSRM [22] between the Design (focused on design and development) and Demonstration (using the artifact to solve the problem) stages. In the Design stage, criteria were defined and described to identify excerpts from the narratives that guide or encourage the student to adopt SCRL "Appendix 1", so that the teacher can objectively base their decision when applying the method. In the Demonstration stage, narratives were classified from a real case of the Software Development Laboratory course, which uses immersive narratives for SCRL [5], taking place in the 2nd semester of the 2nd year of the Degree in Computer Engineering at the Open University of Portugal (asynchronous online Higher Education), implemented in the Moodle. The course follows the e-Sim(Programming) pedagogical approach [6] and used the OC2-RD2 technique [23] to design a narrative based learning context [5], considering the 3 dimensions of narrative immersion presented in section 2.1 [16]. During the DSR iterations, various tests were carried out and a scheme for applying the method (Fig. 1) was developed and is presented in the next section. The results of applying the method are presented in section 5.

4 Method for the Evaluation, Classification of Self-Regulation and Co-regulation of Learning in Immersive Narratives

The method was conceived in four stages that make it possible to evaluate, classify and visualize the classified excerpts of the narrative (line or set of lines), in the conception of narratives for SRL and CRL, in the light of the categories of strategies and criteria that guide or encourage the student to adopt SCRL strategies. We tested, evaluated and classified the narratives and based on the visualization, we reformulated the outline of the Method (Fig. 1) and described each stage (Table 1.). The sequence of the method's stages makes it possible to visualize the SRL and CRL categories on the graph, as each narrative excerpt is assigned a SCRL strategy category in the instrument created to support the operationalization of the method's application in the 1st stage (Table 1.) "Appendix 2". The criteria are intended to support teachers in applying the Method to the evaluation, classification and reflection of narratives for SCRL [7, 18]. They have been

defined and described from the teacher's perspective, so that they can base their decision to foster the desired behavior in the student through the narrative.

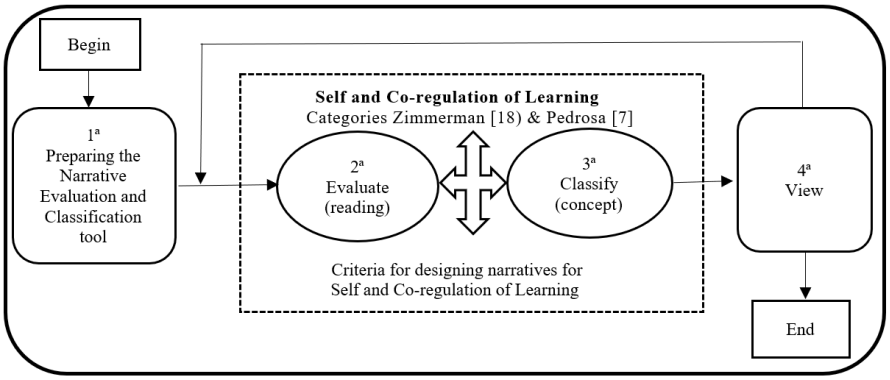


Fig. 1. Method for Evaluating and Classifying Narratives for SCRL.

Table 1. Description of the Stages of the Method for Evaluating and Classifying Narratives.

Stages	Description
Begin	Choose the narrative to evaluate and classify using the method
1st Prepare the Narrative Evaluation and Classification tool	Create a two-dimensional matrix (row x column). Name the columns (Narrative, SRL and CoRL). Separate the narrative excerpts (line by line) by topic or story in the narrative column. Insert a drop-down menu with all the categories in the SRL and CoRL column. Generate a two-dimensional matrix graph in the chosen tool.
2nd Evaluate	Carry out a careful 5eading of the excerpt in order to submit it to the SRL and CoRL categories. Analyze the narrative excerpt in the light of the criteria for evaluating and classifying narratives for SRL and CoRL.
3rd Classification	Select the category covered by the excerpt in the respective SRL and/or CoRL column(s) in which the excerpt falls within the categories of strategies and respective criteria for classification. Take notes to support your reflection on possible adjustments to the narrative to adapt it to the desired category if you wish to change it after classification.
4th View	View the graph to see the overview of the classification of the categories covered. Analyze whether there is a need to make another assessment of the excerpt. This is a point that allows you to reflect and take notes for decisions on necessary and possible changes that you want your narratives to have. Repeat steps 2 to 4 until you have classified all the excerpts from the Narrative.
End	Classification finalized.

During the process of describing the criteria, the category "Reviewing records" (Reviewing Tests, Grades and Textbook) was broken down as being different strategies which imply different activities on the part of the student (e.g., Rereading the tests is an activity to check the student's successes and failures in the tests and implies enhancing their monitoring strategy; Rereading the notes and textbook, a priori, must precede

the tests and assessments, but can be used to clarify the errors and successes in the tests in order to improve their learning in the face of errors), so the breakdown was increased from 17 to 19 categories.

The application of the Method enables the teacher to reflect and become aware of which categories of SCRL strategies need to be strengthened, based on the visualization of the narrative classification graph. Reflection takes place on which aspects and how the narrative can be altered in the light of the criteria that guide or encourage the student to adopt SCRL strategies. During this process, it is necessary to carry out a methodical check, noting down categories to be enhanced and extracts from the narrative to be adjusted or inserted to meet the chosen category.

The pedagogical objective of the lesson and the context of the class should be considered as the delimiter of the narrative, so that the narrative doesn't become too long.

5 Results and Discussion of Applying the Method

The method was applied to real online higher education narratives. In this narrative context, the daily life of a fictitious software development company called SimProgramming is simulated. The employees are characters in the immersive narrative [5]. The character "Boss" is the head of SimProgramming; Meiabola, Patavinas, Ada and Fezada are programmers; Catmming is the artificial intelligence assistant in the shape of a cat - the creative freedom of the narrative. Students are integrated into the company as trainees [6]. SCRL is fostered at various points in the narrative by the characters, especially Catmming, who supports and encourages the students to move forward using metacognitive challenges [24]. The excerpts evaluated and classified for SRL [18] and CRL [7] are shown in Tables 2 and 3.

Table 2. Excerpts by SRL Category.

ID	Categories	Narrative Excerpt Rated	UC topic
1	Self-evaluation hetero-evaluation	**Catmming:** TRUZ-TRUZ People, there are many factors to consider in the software development process! Are you able to develop software with engineering principles in mind?! Has your way of thinking about software development changed after analyzing the post-mortems?! Does the way software is developed have an impact on its evolution?! Let's think about it!	1
2	Organization	**Ada**: Good, you're now more organized in your ideas!	4
3	Transformation	Now you must put these ideas into practice. In other words, make a test plan. To do this, you need to organize these ideas on tables with concrete elements.	4
4	Definition of goals	Download the SimProgramming presentation card file. Develop your presentation. Post your presentation on the Presentation Mural.	1
5	Planning		4

6	Searching for information	Start a new discussion if you have any questions.	2
14	Seeking social help - peers	View the discussions initiated by your colleagues. Interact with your colleagues by taking part in the discussions.	2
19	Record review - Reread the textbook	Tasklist: Review page 85 of the book "Introduction to Software Engineering". Perform the test.	3

Note that we have explicit commands in the narrative on how to encourage the adoption of SRL strategy categories in the speech of the characters Ada and Catmming (excerpts 1 and 2 Table 2).

Table 3. Excerpts by CRL Category.

ID	Categories	Narrative Excerpt Rated	UC topic
2	Organization	**Ada:** Good, you're now more organized in your ideas!	4
3	Transformation	Now you must put these ideas into practice. In other words, make a test plan. To do this, you need to organize these ideas on tables with concrete elements.	4
14	Seeking social help – peers	**Catmming**: As this work is done in teams, choose the team you want to join here. Each team will have to communicate regularly during the internship. Minimum team size: 3 members. Maximum size: 5 members. **Tasklist:** Choose a team; Save the chosen option.	1

Some excerpts are used for SCRL, as is the case with the Transformation category in Topic 4. Seeking social help - peers guide the formation of groups. With the narratives classified, we visualized the graphs (Figs. 2 and 4) to be aware of the categories of SRL [18] and CRL [7] strategies included in the excerpts in Tables 2 and 3 and, based on this visualization, to reflect on the categories to be enhanced.

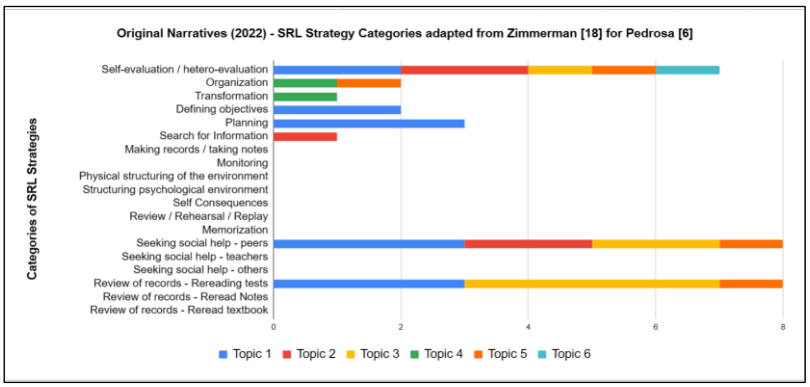
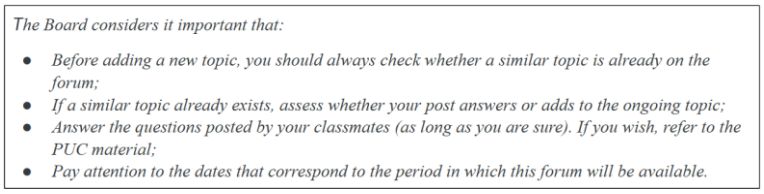


Fig. 2. Classification of Narratives – SRL.

We reflected on how to enhance the categories of strategies not included in the charts and more appropriate to the context, according to the UC's pedagogical goals for SRL. We consulted the categories of strategies and criteria for evaluation and classification in the design of narratives for SRL and CRL. In our reflection, we decided to insert general guidelines before the first topic of the UC, encouraging SRL in the use of the Forums throughout the UC (Fig. 3), in the following categories of strategies: "Planning, Searching for Information, Making Records and Making Notes and Transforming".


The Board considers it important that:

- *Before adding a new topic, you should always check whether a similar topic is already on the forum;*
- *If a similar topic already exists, assess whether your post answers or adds to the ongoing topic;*
- *Answer the questions posted by your classmates (as long as you are sure). If you wish, refer to the PUC material;*
- *Pay attention to the dates that correspond to the period in which this forum will be available.*

Fig. 3. Example of the narrative for SRL (Forum).

This reflection and decision were possible because all the interactions of the teacher mediator in the forums are carried out on behalf of the character “Boss” in the form of an asynchronous interactive narrative, being an extension of the sequential narrative of the topic available in the virtual classroom (Moodle). In Topic 2, we decided to implement a Quiz on a gamified Platform, to encourage the "Memorization" Category of many Application Programming Interface, also contemplating temporal and spatial immersion [13]. We reflected on the possibilities of enhancing the CRL categories [7], only the categories Seeking Social Help from Peers, Organization and Transformation were covered during the application of the method (Fig. 4).

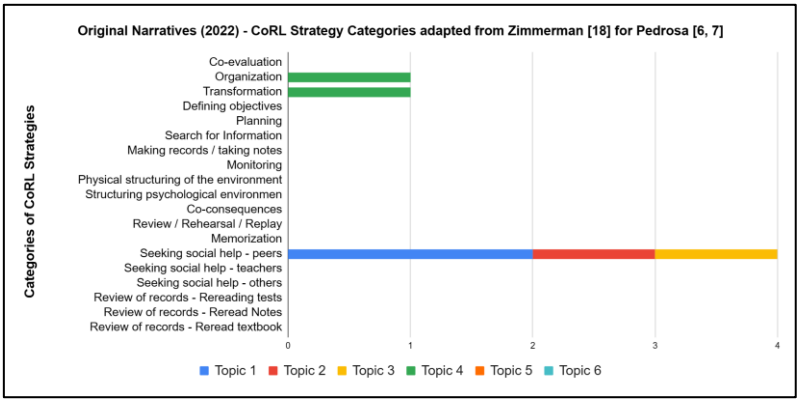


Fig. 4. Classification of Narratives – CRL.

During the course, there is group work at the beginning (Topic 1) and at the end (Topic 6) the final report with the program developed by the group and its documentation is presented. Thought was given to the possibility of creating a virtual room for synchronous meetings to host group meetings with the aim of increasing CRL [7] in the

categories: Physical Preparation of the (virtual) Environment, Organization, Planning, Definition of Goals and Transformation. There was no need to insert new CRL categories, since there is only one group work in the entire course and the narratives should not be too long. During the application of the method, we carried out a methodical control of the notes of possible changes and the insights realized, which made it possible to reflect on the changes presented in this section.

The method differs from those identified in the literature to support CoRL [19] and SRL [20] in that it uses immersive narratives [16] as a teaching resource; it provides a scheme and criteria for evaluation and an instrument for classifying the narratives that supports the process.

6 Conclusions

This work presented and applied a Method for Evaluating and Classifying SCRL in Immersive Narratives, for application in online higher education as a teaching resource. It is a reproducible structure developed as an artifact of DSR, which makes it possible to reflect excerpts from narratives to encourage the adoption of SCRL strategies in online higher education. The method gives teachers the chance to study student performance in each version of the narrative, with a greater awareness of the strategies used and those that can be encouraged so that students achieve a greater degree of success in the course. The adaptation of the respective SCRL categories, which involves breaking down those that have different activities, as well as the definition and description of the criteria for assessment and classification of narratives, allow the teacher to have objective conditions available to support the application of the method in their context. The strongest aspects of the analysis in the development and application of the method are the scheme structured in 4 stages and the respective categories of strategies and criteria that guide or encourage the student to adopt SCRL strategies, to support the teacher in reflections and decisions to foster SCRL in immersive narratives as a teaching resource. A weakness of this work focuses on reflections on CoRL that has not yet been implemented (i.e. Physical Preparation of the Environment - virtual) to verify its impacts. The main limitation of this article is the application of the method to just one specific case, so future work could include applying it to other subjects in online higher education and in other contexts to increase its robustness; and extending the literature review to enable a comparative analysis with existing methods or tools to improve CoRL strategies in online higher education.

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"Appendix 1"
Categories of strategies and criteria for designing narratives for SRL and CoRL https://zenodo.org/records/10728908.
"Appendix 2"
Support tool for Stage 1 of the Method: https://bit.ly/4bh2mCB.

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