



Cooperative game as an educational product to teach mathematics: initial and continuing training

Jogo cooperativo como produto educacional para ensinar matemática: formação inicial e continuada

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Abstract

This article presents results of the validation of a cooperative board game as resource for teaching statistics in the Early Years of Elementary School, an educational product developed in Science, Mathematics and Technologies Teaching Graduate Program at Santa Catarina State University (UDESC). Some academics of UDESC Degree course in Mathematics participated in an intervention when they evaluated the educational product. This evaluation was interpreted through Content Analysis, which evidenced the participants' opinions and suggestions for adjustments and resulted in the conclusion that the product really has characteristics of a cooperative board game and that it fulfills the objective of teaching statistics to the Early Years of Elementary School with an adequate pedagogical and methodological proposal. The intervention led to the reflection presented in this text, both on cooperative board games and on relationships between initial and continuing education of mathematics teachers that can be motivated by a professional master's research.

Keywords: Statistical Education; Early Years of Elementary School; Professional master's; Cooperative board game.

Resumo

Este texto apresenta resultados da validação de um jogo cooperativo de tabuleiro como recurso de ensino de estatística nos Anos Iniciais do Ensino Fundamental, um produto educacional desenvolvido no curso de mestrado profissional do Programa de Pós-Graduação em Ensino de Ciências, Matemática e Tecnologias (PPGECMT) da Universidade do Estado de Santa Catarina (UDESC). Acadêmicos do curso de Licenciatura em Matemática da UDESC participaram de uma intervenção, quando avaliaram o produto educacional. Essa avaliação foi interpretada por meio da Análise de Conteúdo, o que evidenciou as opiniões e as sugestões dos participantes e resultou na conclusão de que o produto possui características de um jogo cooperativo e de que cumpre com o objetivo de ensinar estatística aos Anos Iniciais do Ensino Fundamental com uma adequada

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proposta pedagógica e metodológica. A intervenção levou à reflexão apresentada neste texto, tanto sobre jogos cooperativos, quanto sobre relações entre formação inicial e continuada de professores de matemática que podem ser motivadas por uma pesquisa de mestrado profissional.

Palavras-chave: Educação Estatística; Anos Iniciais do Ensino Fundamental; Mestrado profissional; Jogo cooperativo de tabuleiro.

Introduction

In this article, we present an excerpt from the research developed by the first author, under the guidance of the second author, in the professional master's course of the Graduate Program in Science, Mathematics and Technology Teaching (PPGECMT) of the Santa Catarina State University (UDESC). This is a discussion about one of the validation steps of the educational product developed in the course, which was executed with the support of the knowledge built by the first author (then a master's student) in the subject Supervised Teaching Practice, taught by the third author.

With this presentation, we aim to highlight strategies chosen for prior validation - the final validation took place in the dissertation board - of an educational product in a professional master's course. Moreover, we discuss the relations between these choices and the teaching process of knowledge construction for the teaching of mathematics, whose sources were the training of those involved: the continued training of the master's student, and the initial training of the undergraduate students of Mathematics who collaborated with the research by evaluating the educational product.

In the first section, we highlight research contexts to present relations between professional masters, supervised professional practice, development of educational products and teacher training, as well as to synthesize themes related to the research: statistics teaching in the early years of elementary school and cooperative games. The second section characterizes the methodology that was used for the previous validation of the educational product. We present the cooperative board game that was developed during the professional master's degree at PPGECMT and explain how the process of its prior validation was conducted with the support of an intervention carried out as an activity of the course Supervised Teaching Practice with students from the Mathematics undergraduate course. In the third section, we analyze the data collected and discuss the results to highlight the participation and contributions of the participants in the process. We end with reflections that conclude the discussion about the use of cooperative games to teach statistics content (mathematics) in the Early Years of Elementary School, reflections that were made possible thanks to the interlocution of the initial training with the continued training of teachers who teach (will teach) mathematics. Moreover, we promote a discussion about the relations between continuing education and initial training that can be established through interventions related to validation processes of educational products and supervised professional practice developed in professional courses in the area of education.

Presentation of research contexts

Professional Master's Degree, Educational Product and Supervised Professional Practice

The professional master's modality was instituted in Brazil in 1995⁴, regulated in 1998⁵ and updated in 2009⁶ and in 2017⁷. Barros, Valentim and Melo portrayed this scenario and highlighted the role of the professional master's degree as a training course at the graduate level:

The professional masters can be thought of as a type of postgraduate training that involves a great diversity of specific formats for its operation. It is the **training for transforming professional practice through the incorporation of the scientific method**. It is aimed at an audience preferably coming from outside the academy **and is intended for the management, production and application of knowledge oriented to applied research, problem solving, the proposition of new technologies and technological improvements**. [...] It comes to fill gaps created by a latent demand, more expressive in certain areas of knowledge than in others, interested in **advancing under the aspect of a highly qualified professional training**. (Barros, Valentim & Melo, 2005, p. 131, emphasis added).

In the area of Teaching, according to Osterman and Rezende (2009, p. 77), such modality "is strongly linked to the research conducted in this field of action" and takes "the immersion of the teacher in his school reality and his knowledge of the problems faced in it as reference points for the development [of the product] to be proposed". We understand, thus, that in a professional master's course in the area of Teaching, research is conducted whose objective is the development of an educational product aimed at meeting demands in the area, recognized as something relevant by the master's student conducting it. "The idea that an educational product needs to be developed in a [professional master's degree in teaching] was the way to put CAPES legislation into practice in programs at several Brazilian universities." (Ostermann et al., 2009, p. 70). Moreover, "the professional master's [...] allows for experimentation with innovations in curricular designs and ways of teaching and learning", [...] has "a naturally multidisciplinary orientation" and "must have standards of demand as rigorous as those of the academic master's, only with different criteria, because they are courses of a qualitatively different nature". (Fisher, 2005, p. 28).

⁴ [Portaria nº 47, de 17 de Outubro de 1995](#) GAB/CAPES - Determines the implementation in Capes of appropriate procedures for the recommendation, monitoring and evaluation of master's degree courses aimed at professional training

⁵ [Portaria nº 80, de 16 de Dezembro de 1998](#)- GAB/CAPES - Provides for the recognition of professional master's degrees and makes other provisions.

⁶ [Portaria Normativa nº 17, de 28 de Dezembro de 2009](#) - GAB/CAPES - Provides for the recognition of professional master's degrees and makes other provisions. Ordinance No. 80, of December 16, 1998 - GAB/CAPES - Provides for the recognition of professional master's degrees and makes other provisions.

⁷ [Portaria nº 389, de 23 de Março de 2017](#) - GAB/MEC - Provides for professional master's and doctoral degrees within the scope of stricto sensu graduate studies

According to the Area Document⁸ - Area 46 Teaching - published in 2019, on page 15: "the Area of Teaching is one of the pioneers in offering Professional Master's courses (since 2001)", being:

Unlike the Academic Master's, **in the Professional Master's, the student needs to develop a process or educational product and apply it in real classroom conditions or other teaching spaces, in a handmade or prototype format.** This product can be, **for example, a didactic sequence, a computer application, a game, a video, a set of video classes, an equipment, an exhibition, among others.** The dissertation/thesis should be a reflection on the elaboration and application of the educational product supported by the theoretical methodological framework chosen. (p. 15, emphasis added).

Regarding the educational product, still from the 2019 Area Document, we highlight:

The Teaching area **understands as an educational product the result of a creative process generated from a research activity, in order to answer a question or a problem, or even a concrete need associated with the field of professional practice,** and may be a real or virtual artifact, or even a process. (p. 16, emphasis added).

The characterizations of the professional master's degree and the educational product presented so far are relevant for the readers of this article to understand the meanings of the intervention that will be reported. It is also important to mention another guideline given by the 2019 Area Document:

For the professional modality (Master's and Doctorate), the **Supervised Professional Practice is a mandatory item for curricular completion and should include the monitoring of the professional by the program, through guidance or specific discipline for this purpose.** It is the opportunity for the program to get to know the school and/or field of professional practice, to get to know the student's workplace, and to **enable the monitoring of the implementation of the proposal that will generate the reflection present in the dissertation/thesis about the elaboration, application, and validation of the educational product.** It is emphasized that the supervised professional practice is also an opportunity for the program to expand its actions of social insertion. (p. 16, emphasis added).

In the professional master's program, the supervised practice - either through orientation or discipline - is a moment of training for students preparing for research, but also, by addressing issues related to teaching, for the exercise of the profession.

Reflections on the continuing and initial formation of teachers

Teacher training can be discussed in the light of different theoretical supports and generate reflections on the most varied aspects. In our research, we chose the interlocution with Shulman's (2014)⁹ ideas about the knowledge bases for teaching that are part of the teacher education process and in which sources these bases can be built, from the perspective that "teaching necessarily begins with the teacher understanding what is to be learned and

⁸ <https://www.gov.br/capes/pt-br/centrais-de-conteudo/ENSINO.pdf>

⁹ Shulman (2014) is a translation of Leda Beck of the original: Shulman, L.S. (1987). Knowledge and Teaching Foundations of the New Reform. Harvard Educational Review, 57(1), 1-22.

how it is to be taught." (Shulman, 2014, p. 205). In the context of the research, such a choice was made to support our understandings of how knowledge was constructed (the base) in the exchanges of experiences between researcher and participants that occurred in the intervention conducted in the supervised professional practice of the master's course (the source).

One of the categories of the knowledge base for teaching, according to the author, is "Pedagogical Content Knowledge" (PCK), "most likely the category that best distinguishes the understanding of a content specialist from that of a pedagogue" which "represents the combination of content and pedagogy in understanding how specific topics, problems, or issues are organized, represented, and adapted for the diverse interests and aptitudes of students, and presented in the educational process in the classroom." (Shulman, 2014, p. 207). From this perspective, we understand that a teacher's content knowledge is not limited to his or her knowledge about the content per se, but rather involves knowing the different elements related to teaching that content. Regarding the possible sources for the construction of this knowledge, Shulman (2014, p. 207) addresses the "academic training in the areas of knowledge or disciplines," a space that encompasses different opportunities and potentialities for theoretical and practical actions. This was the scenario that presented itself in the realization of the intervention that we planned, applied, and analyzed in the professional master's degree.

Teaching statistics in the early years of elementary school

The learning of statistical content in elementary school is the focus of Mathematics Education when discussing, among other issues, its relevance in the formation of students to critically understand information in the form of graphs, tables, and statistical data that they face on a daily basis. We can point to an example that illustrates this situation and that has affected all of us, including children, since the first quarter of the year 2020: information about data related to the transmission of the new coronavirus in the COVID-19 pandemic¹⁰. How do you read and interpret data shown in the disease evolution graphs and understand how they relate to the region where you live?

In the guidelines, objects of knowledge, and skills of the Common National Curricular Base (BNCC) for Primary Education, the thematic unit Probability and Statistics thus manifests the relevance of mathematics teaching:

It [the thematic unit Probability and Statistics] proposes to address concepts, facts and procedures present in many problem situations in everyday life, science and technology. **Thus, all citizens need to develop the skills to collect, organize, represent, interpret, and analyze data in a variety of contexts in order to make informed judgments and appropriate decisions.** This includes reasoning and using

¹⁰ Infectious disease caused by the SARS-CoV-2 coronavirus that led to the 2020 pandemic that still extends to 2021. As of the date this note was written (14/02/2021), press data report that there are more than nine million and eight hundred thousand cases in Brazil (with approximately two hundred and thirty-nine thousand deaths) and more than one hundred and eight million cases in the world (with approximately two million and four hundred thousand deaths).

statistical concepts, representations, and indices to describe, explain, and predict phenomena. (Brazil, 2017, p. 274, emphasis added).

Such guidelines are supported by studies such as Lopes (2004) - for whom the teaching of statistics contributes to the student's reflection about his reality in a critical and reflective way - and Lopes and Carvalho (2005), who emphasize that the contents of statistics should start from the resolution of students' everyday problems. And, according to Lopes (2012), it is not possible to wait until the student reaches high school to start working with such content, because children are also exposed to statistical data.

Cooperative games as a teaching resource

A cooperative game is one whose rules and dynamics guide a non-competitive participation among players. This happens when they work together to achieve a common goal, in moves in which actions are shared, including victory, and team spirit, help, and companionship among participants are valued (Brotto, 1995, 1999; Soler, 2003), with no classification between winners and losers (Orlick, 1989). In this way, the focus of the players is not on competing against each other, because winning or losing is not what matters in games like these, but on practicing cooperation, acceptance, and help to reach a final goal, which is collective. (Soler, 2003). Having these characteristics, that is, without the goal of ranking or defeating someone, the cooperative game can favor inclusion. (Brotto, 1995).

This characterization reflects reasons why a cooperative game can be a didactic teaching resource that values cooperation over competition, stimulates group work, promotes inclusion, and companionship. Thus, beyond the potential of teaching school content, they also act in the human formation of students.

Methodology of prior validation of the educational product with the participation of Mathematics undergraduate students

Description of the educational product: a cooperative game

In the professional master's course of the PPGECCMT of UDESC, under the guidance of Prof. Luciane Mulazani dos Santos, we developed, in the period from 2018 to 2019, an educational product in the format of a cooperative board game with the aim of proposing a didactic resource for teaching statistics content for students of the Early Years of Primary Education. The previous validation of this game was performed through an intervention that was planned and applied with the support of a supervised professional practice discipline which, in the PPGECCMT, is called Supervised Teaching Practice and, at the time, was taught by Prof. Ivani Teresinha Lawall. The final validation of the educational product was done in a dissertation defense board.

The game was entitled "The Adventures of Rats". It has the format of a board and its pieces, scenario, and plot were based on the story of the children's book "Escaping from the Claws of the Cat" (Yunjeong & Sun-Yeong, 2010). It has the dynamics of a cooperative game - that is, it is not competitive - with three phases for different levels of challenges, with

each phase referring to a mission that, to be fulfilled, requires students to solve problem situations working cooperatively in teams. (Silveira, 2019b). Figure 1 shows its complete and final version.



Figure 1 - Cooperative game "The Adventures of Mice".
Source: Silveira (2019b).

The complete description of the cooperative board game "The Adventures of Rats" can be found on the Edu CAPES Portal of open educational objects¹¹, where all materials can also be downloaded for reproduction.

Geared to the early years of elementary school to teach the construction, reading and interpretation of bar graphs and tables, this educational product met the BNCC guidelines for statistical content:

The reading, interpretation, and construction of tables and graphs have a fundamental role, as well as the form of production of written text for the communication of data, because it is necessary to understand that the text should synthesize or justify the conclusions. (Brazil, 2017, p. 275).

The previous validation of the educational product was done during the course of the Supervised Teaching Practice discipline of PPGEcMT in the form of an intervention carried out with academics of the Mathematics Degree course of UDESC, who tested a prototype of the game and evaluated it through a questionnaire. After this preliminary validation, the game underwent adjustments and its final version was validated in the dissertation defense board.

The intervention practice

The previous validation of the cooperative game was done with a qualitative research approach, of an interventional nature. The procedures indicated in Teixeira and Megid Neto

¹¹ <https://educapes.capes.gov.br/handle/capes/552901>

(2017) were used: planning, application (execution), and analysis of the data collected in the intervention, which are described below.

Planning

We planned to carry out a practical activity in the participants' natural environment, the classroom, in the Mathematics Degree course at UDESC so that the intervention actions would achieve the goal of providing subsidies for the previous validation of the educational product. This planning was done together with the supervisor and the teacher of the subject Supervised Teaching Practice.

Execution (application)

The application took place in the second semester of 2018 and counted with the participation of Mathematics undergraduate students from UDESC who were taking the subject Didactics of Mathematics, taught by the research supervisor. It was carried out during classes, on two days, totaling 4 hours/class of 50 minutes each. The data sources were the observation of the participants' activities and an online questionnaire prepared on Google Forms and made available to the students on Moodle to record the results of the game evaluation done by each participant.

The first day of the practice was divided in two moments, with the participation of eighteen students. The first moment of this first day was dedicated to information about the research and to general orientations about the participation of the students. We presented to the students the objectives of the professional master's research and the educational product; we explained to them the dynamics of the practical activity that would be carried out and, mainly, the reason for their participation. We explained to them that they should be in two concomitant positions to evaluate the educational product: to play as if they were students in the early years of elementary school and to analyze the game through their eyes as future mathematics teachers. They knew that they could help us verify if the game had the potential to promote cooperation among players, if the pedagogical proposal of the game was adequate, if the contents of statistics were correctly addressed in the game materials and throughout the game dynamics, as well as indicate what deserved to be changed or adapted. After clarifying the forms of involvement of the students, they all signed and handed us the consent forms for participation in the research and authorization for the use of images.

The second moment consisted of the stages involving the game. As planned in the research, we started by reading the book "Escaping from the Cat's Claws", by Choi Yun-Jeong (author) and Kim Sun-Yeong (illustrator), translated into Portuguese by Thais Rimkus. To better present it, we projected the pages of the book on the board with multimedia equipment. After the reading, we asked the class to divide themselves into groups of three and we gave each group a board. This board was a prototype, that is, after the previous validation of the educational product it would be treated to a final version. Once the boards were handed out, we presented the groups with the game rules and asked them to start the games. For the sake of organization, all groups followed the same steps at the same time,

following the projection of the problem situations on the board. Figures 2 and 3 show this dynamic.



Figure 2 - Board of the game prototype.
Source: Silveira (2019a).

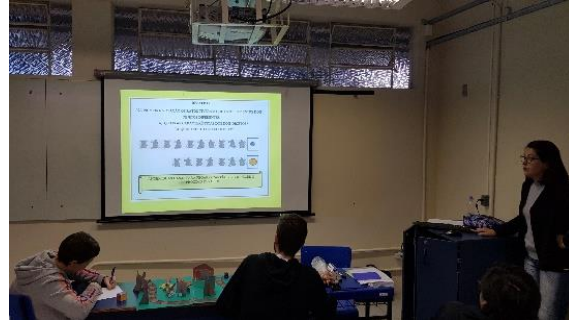


Figure 3 - Problem-situation.
Source: Silveira (2019a).

After all groups finished the game missions, we ended the first day of the intervention. Throughout the practice, discussions pertinent to the objective of the previous validation took place, which were noted by the participants in their materials and recorded by the researcher in a logbook.

The second day of the practice involved the participation of fourteen students - since four did not show up - to evaluate the practice and the educational product. We invited the students to access a link to a form on the Moodle platform with questions where they registered their evaluations of the game. Some of them answered using the computers available in the room and others used their own cell phones. After everyone said they had finished their evaluations, we ended the practice with a thank you for the collaboration.

Data analysis and discussion of results

The data collected through the questionnaire applied to the students after the intervention formed a text corpus that was analyzed with methodological procedures of Content Analysis (Bardin, 2009) in order to interpret what was explicit in the answers and, thus, understand the perceptions of the students about the educational product. It is worth mentioning that in the master's research other data sources were also analyzed, such as the logbook records and other practices. For this article, due to its objective and delimitation, we chose as a cutout the presentation of the analysis of the text formed by the answers given by the Mathematics undergraduate students to the evaluation questionnaire of the educational product.

According to Bardin (2009), the Content Analysis requires the transformation of the text corpus, through clipping, aggregation or enumeration, until its codification reaches the representation of the content or its expression. For this to happen, it recommends a three-step analysis process: (1) pre-analysis, through the organization and reading of the texts; (2) exploration and description of the relevant texts, (3) treatment of the results after interpretation of the collected data. In this sense, Content Analysis aims to describe and

interpret what is expressed in a text to show understandings about a specific situation. To this end, categorization is a central procedure.

Considering the needs of the research that demanded the intervention, questions 1 and 2 of the questionnaire were designed with the objective of identifying the perceptions of fourteen participating students about the characteristics of the game so that, with the analysis, we could understand if this educational product had the potential to promote cooperation:

Question 1: The game presented is characterized as a cooperative game. What are the elements that you noticed during the gameplay that make it cooperative?

Question 2: What aspects differentiate this game from other games?

The process of content analysis of the answers given to Question 1 led to the identification of context units from which four categories emerged: teamwork; collective discussions and reflections; voting for choices; there is no competition. Chart 1 shows an example, from the answers given by the academics P1, P2, P3 and P4, of the analysis process that related the units of context to the categories.

Chart 01 - Categorization of the collected data.

Categories	Context Units
There is no competition	"(...) everyone must help each other so that the team comes to the end victorious." (P1)
Collective discussions and reflections	"The game allows students to talk with others in their group, holding discussions, and coming to agreements." (P2).
Voting for choices	"The three on the team should 'vote' and make a democratic choice." (P3)
Teamwork	"The need to work with each other, using not only their own skills, knowledge or reasoning, but those of their colleagues" (P4)

Source: survey data (2018).

Done analogically, the analysis of all the answers to Question 1 resulted in the categories being made explicit in the way shown in Figure 4.

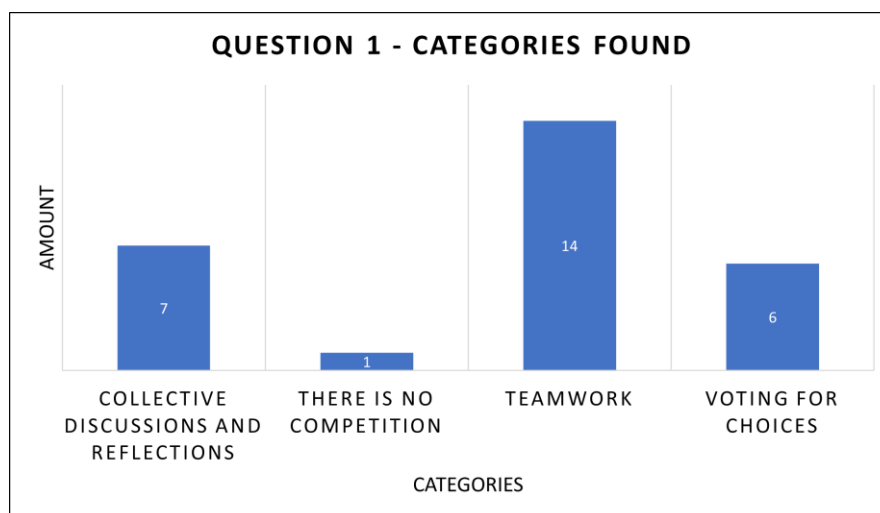


Figure 4 - Presentation of the categories emerging from Question 1.

Source: research data (2018).

The process of content analysis of the answers given to Question 2 led to the identification of context units which led to the emergence of four other categories: encouraging the participation of all; dynamics of the game; no opponents/losses; sharing knowledge. Chart 2 shows an example, from the answers given by the academics P5, P6, P7 and P8, of the analysis process that related the units of context to the categories.

Table 2 - Categorization of the collected data.

Categories	Context Units
Incentive for everyone to participate	"Everybody helps each other." (P5).
Game Dynamics	"Everyone's search for a common answer, from dialogue." (P6).
There are no opponents/losers	"One student doesn't try to be better than the other." (P7)
Knowledge Sharing	"Team members share knowledge with each other (...) those who don't know learn from their colleague." (P8)

Source: Source: research data (2018).

Done analogically, the analysis of all the answers to Question 2 resulted in the categories being made explicit in the way shown in Figure 5.

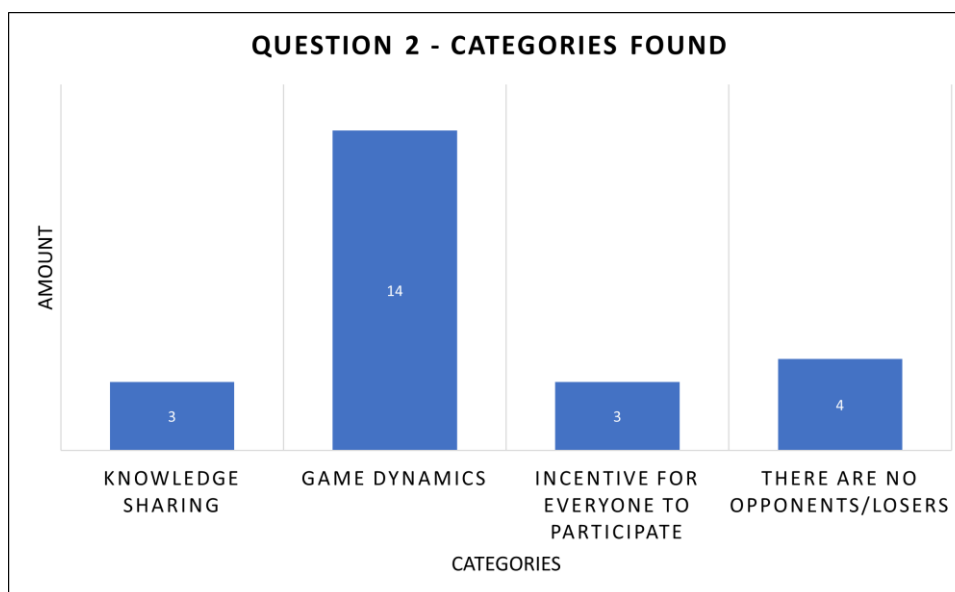


Figure 5 - Presentation of the categories emerging from Question 2.

Source: research data (2018).

The graphs shown in Figures 4 and 5 indicate that all the academics said they perceived that the element "teamwork" was responsible for characterizing the game as cooperative, and also identified that the aspect that most differentiated the game in relation to others they know was "game dynamics". In interpreting this result, we conclude that the academics validated the educational product as being a cooperative type game whose main characteristic is a dynamic that promotes group work, that is, providing participants with the experience of playing "to overcome challenges and not to defeat others." (Brotto, 1999, p. 88). Thus, we see that it was possible to develop a game in the perspective pointed out by Soler (2003), in which the focus is not on competing - because winning or losing is not what

really matters - but rather on showing the values of cooperation, acceptance, and help among team members to achieve a final goal.

Question 3, designed to interpret whether the participants believe that the game could be used as a teaching resource, was: **"Do you think this game has potential - in terms of methodological proposal - to be used as a resource for teaching and learning in mathematics classes in the Early Years? Why?"**.

The process of content analysis of the answers given to Question 3 led to the identification of context units, from which two categories emerged: the game has an adequate proposal and meets the proposed goals; the game has an adequate proposal but may not meet the proposed goals. Chart 3 shows an example, from the answers given by the academics P9, P10 and P11, of the analysis process that related the units of context to the categories.

Chart 3 - Categorization of collected data

Categories	Context Units
The game has an adequate proposal and meets the proposed objectives.	"The game is in the ideal age range and has a great mathematical and didactic approach, attracting the student to pay attention to the story and participate in the decisions that appear in it, thus already having a learning in an indirect way." (P9)
The game has an adequate proposal, but it may not achieve the proposed goals.	"It depends on each student, on their level of interpretation of what is asked." (P10) "I am not used to cooperative games, so I found the proposal strange initially. I am a very competitive person and the fact that it was cooperative discouraged me from participating (...) somehow, I would generate a competition among the trios, to try to motivate the children more to participate." (P11)

Source: survey data (2018).

Analogously, the analysis of all answers to Question 3 resulted in the categories being made explicit in the way shown in Figure 6, that indicates that all the academics considered the game to have an adequate proposal. By interpreting this result, we conclude that the educational product was validated by the class in terms of its proposal and can be used as a teaching resource. Of this total, about 14% of the students questioned the achievement of the teaching objectives through a game with the proposal presented. Returning to the information in Chart 3, we find the two responses that showed this interpretation for the caveat "...but it may not achieve the proposed objectives":

"It depends on each student, on their level of interpretation of what is asked." (P10)

"I am not used to cooperative games, so I found the proposal strange initially. I am a very competitive person and the fact that it was cooperative discouraged me from participating (...) somehow, I would generate a competition among the trios, to try to motivate the children more to participate." (P11).

We interpret that the answer of academic P10 is related to his perception that student participation is related to their interpretations of what teachers request in teaching activities.

In this sense, we understand that this caveat is not specifically related to the game that was being evaluated, but to the generality of teaching resources.

Regarding the answer of student P11, we interpreted it as an important element for discussion about the insertion of cooperative games in teaching processes of mathematics content: possible resistance to accept collaborative dynamics for board games, since most of the practices used are competitive. This conclusion was important for the research because it made even more firm the purpose of developing a cooperative game that would break paradigms related to competitiveness in the classroom.

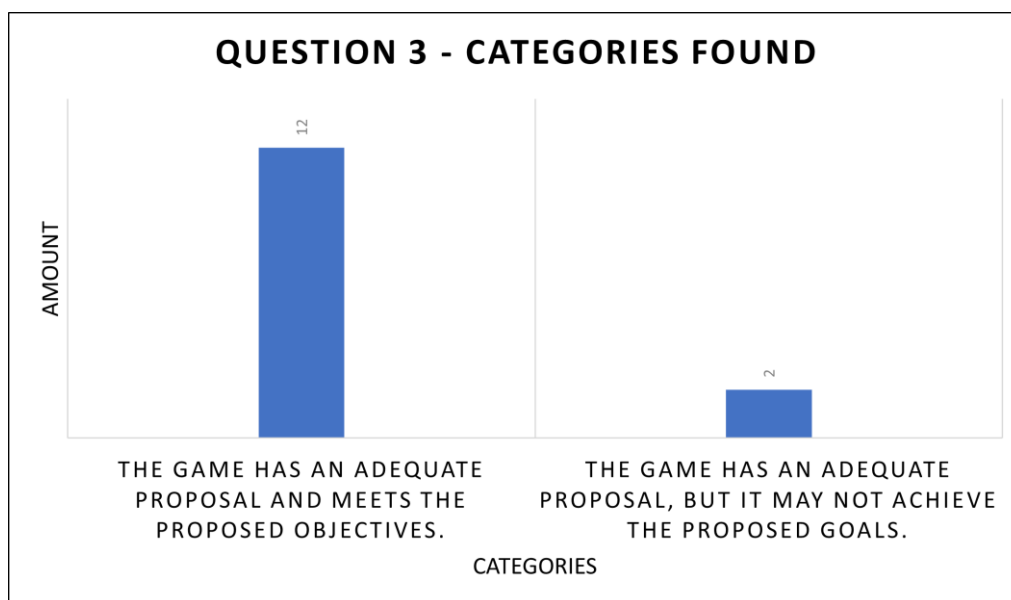


Figure 6 - Presentation of the categories emerging from Question 3.

Source: research data (2018).

Question 4 was: "In your opinion, do the questions in the game cover the contents of reading, interpretation and construction of graphs and tables? What would you suggest as an improvement in the game to achieve these objectives?".

The process of content analysis of the answers given to Question 4 led to the identification of context units, which led to the emergence of the category: the questions explore the expected contents, without the need for adjustments. The answers of all the participants fell into this category. In interpreting this result, we conclude that the academics validated the educational product with respect to the statistical content worked through the cooperative game, i.e., the game enables the appropriate exploration of the statistical content for teaching in the early years of elementary education.

The last question was **Question 5**: "What are your suggestions for improving the elements of the game, such as rules, plot, scenario, materials used, etc.?"

The process of Content Analysis of the answers given to Question 5 led to the identification of context units which brought out six categories: adjustments regarding the rules; adjustments regarding the scenario; adjustments regarding the plot; adjustments

regarding the materials used; adjustments regarding the dynamics of the game; modifications regarding the problem situations. Chart 4 shows an example, from the answers given by the academics P2, P3, P4, P5, P6 and P7, of the analysis process that related the context units to the categories.

Chart 4 - Categorization of collected data

Categories	Context Units
Adjustments to the rules	"Decide how to unravel the issues." (P2)
Scenario Adjustments	"Naming the cat and the game." (P3)
Script adjustments	"Adding pieces to the board." (P4)
Adjustments to the materials used	"Stability in the pieces, so they don't keep falling off." (P5)
Game dynamics adjustments	"Change the order of the second and third phase." (P6)
Changes to the problem situations	"Take care with ambiguous issues." (P7)

Source: survey data (2018).

The graph shown in Figure 7 shows that all the academics suggested modifications in the problem situations. In addition, we received two specific suggestions for adjustments in the rules, one for adjustments in the scenario, three for adjustments in the storyline, five in the material used in the construction of the game elements, three in the game dynamics. By interpreting this result, we concluded that the educational product needed adjustments in these game elements, which were made later in the process of adapting the game prototype to the final version.

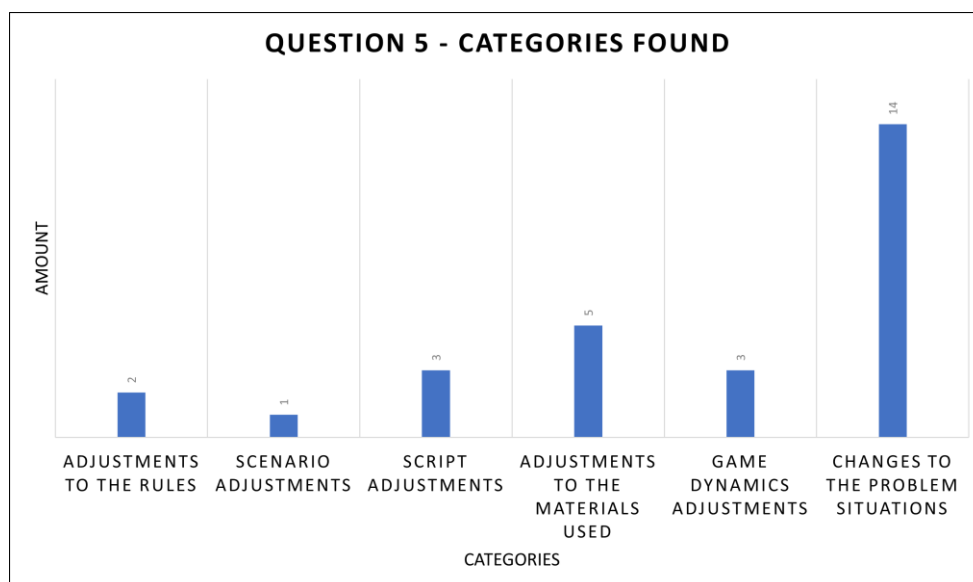


Figure 7 - Presentation of the categories emerging from Question 3.

Source: research data (2018).

We consider that this contribution was fundamental for the finalization of the educational product. In order to highlight the importance of the undergraduate students' participation in the previous validation, it is worth mentioning that two other validation moments were performed throughout the research, one of them with 5th grade students in Elementary School and another with teachers who work in the Early Years. However, only

the Mathematics undergraduate students pointed out, in a critical and reflective way, necessary adjustments in the texts of the game's problem situations, both for a better understanding of the objectives and for the correction of the mathematical language.

At the end of the analysis of the results, we reflected on the observation of the relations that were established in the intervention made, promoted by a professional master's student in teaching (therefore, in a continuing education process) with the participation of students from a Mathematics undergraduate course (therefore, in an initial education process). It was interesting to observe how the dynamics of the intervention activities enabled discussions about the educational product itself, but also others that were directly related to the formation of teachers who teach mathematics and that served all involved. In the case of the undergraduate mathematics students, even though their training is focused on the final years of elementary school and high school, for them it was important to analyze teaching from another perspective of their profession, which is the teaching of mathematics in the early years of elementary school. On the other hand, their vision about what they learn in the Mathematics course helped the graduate student to understand aspects of her own training about the specificities of Elementary I (1st to 5th grade), which led to reflections about the impact of the learning outcomes of this school stage for the teaching that takes place in the Final Years of Elementary School and in Secondary School. Thus, by bringing together initial and continuing education and, more than that, by bringing together two different focuses of teacher education - teaching mathematics in Kindergarten and Primary I; teaching mathematics in Primary II or Secondary School - the research made it possible for everyone to get in touch with themes and contents that are not only specific to their (future) area of work, but also those that impact the learning of mathematics in the school as a whole.

Final considerations

With the intervention, we achieved the goal of validating an educational product aimed at the Early Years of Elementary School from evaluations made by students from a Mathematics undergraduate course. In addition, we realized important opportunities to build pedagogical and content knowledge for all participants, i.e., for both the student and the future mathematics teachers in training in the undergraduate course.

Regarding the educational product that was under previous validation, it was essential to receive the criticism of the Mathematics undergraduate students about the mathematical and statistical content present in the game, as it brought us relevant suggestions for adjustments that were taken into consideration in the transformation of the prototype into the final version. In addition, the interpretation of the results of the evaluations of the participants of the intervention led us to confirm its characterization as a cooperative game.

The educational product "The Adventures of the Rats", with contributions from the students of the Mathematics course, was a didactic resource that presented an adequate pedagogical and methodological proposal for the use of a cooperative board game to teach

children in the early years of elementary school to build, read, and interpret tables and bar graphs.

Throughout the intervention, the process of discussing the educational product and reflecting about its use in the classroom also resulted in the conclusion that cooperative games have the potential to act in a holistic way of education where not only the teaching of school contents is privileged, but also the development of other aspects of human formation, such as working in groups to achieve goals that are good for everyone to learn, collaborate, include, respect the other's opinion, besides the development of self-esteem, trust, and solidarity.

Regarding training courses as a source of knowledge construction for teaching (Shulman, 2014), we emphasize the importance of the relationship established between initial and continued education, when promoting an intervention in the undergraduate course proposed by the professional master's course in the context cited in Barros et al. (2005):

The professional master's degree can be thought of as a type of postgraduate training that involves a great diversity of specific formats for its operation. It is training for transformative professional practice through the incorporation of the scientific method. (Barros et al., 2005, p. 131, emphasis added).

Thus, we see that the intervention activity carried out in a discipline of the professional master's degree within the scope of a scientific research and articulated with an initial teacher training course served beyond the previous validation of the educational product: it contributed positively to our teaching training (of the master's student, the supervisor and the teacher of the supervised practice discipline) and also to the training of the participating undergraduate students.

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