

## Transdisciplinary approach for the development of exploratory research with adults and children

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**Abstract.** *This article describes an experience of a transdisciplinary approach for the exploratory study of a student reward system. Differentiated techniques were used to collect data, whether they were aimed at adults or students. To delve into the object of study, a mixed, quantitative and qualitative approach was carried out. Through the triangulation of the various data obtained and through both, statistical and supported by Text Mining and Natural Language Processing analysis techniques, was made visible the behavior of the students when using the tool focus of analysis.*

### 1. Introduction

As noted in the declaration and recommendations of the International Congress on Transdisciplinarity [CIRET-UNESCO 1997] “we cannot continue to parcel out knowledge; we need a transdisciplinary approach”, this statement calls for an overall, systemic and non-divided vision of the scientific field to its objects of study. This epistemological, ontological and methodological discussion, ultimately promotes a paradigm shift in research. The methodological approach of the Human Sciences has traditionally been different from that of the Natural Sciences, given their high biological, psychological, and sociological complexity. For this reason, the approaches must also reflect this complexity, since, as Martínez Miguélez, M. (2009) mentions, “we cannot seek solely economic solutions to economic problems, nor solely political solutions to political problems, nor solely social solutions to social problems (...). In all fields it is seen that the majority of problems cannot be resolved at the level at which they are posed, that their nature forms a complex rhizome of very varied interactions”. This statement supports a transdisciplinary vision, which calls for going beyond monodisciplinary approaches, to overcome the parceling and fragmentation of knowledge and, consequently, the hyper-specialization and inability to understand the complex realities

of today's world, which are distinguished, precisely, by the multiplicity of the links, relationships and interconnections that constitute them [Stanchef et al. 2016].

In this sense, a question that may arise for the reader is what is the difference between the terms multi, inter, trans-disciplinarity. In first instance, these various approaches refer to the research process that goes beyond what is merely focused on particular disciplines, which are developed at various levels along a continuum. These levels range from monodisciplinary to multidisciplinary, and in their interaction, from interdisciplinary to transdisciplinary. However, these concepts are not interchangeable, since each of them implies a different work structure. For example, in a multidisciplinary investigation, different specialists collaborate on a common project. The participants belong to various disciplines, but each one is independent in their work, without needing to know the work of others. In an interdisciplinary investigation, for the formulation of the action plan and the individual contribution, each member tries to take into account the procedures and work of the others in view of a common goal. Therefore, coordination, communication, dialogue and exchange are fundamental. Transdisciplinary research goes beyond each discipline and adds the fact that it is constituted by a complete theoretical and practical integration that becomes essential to improve results. In it, participants transcend their own disciplines, managing to create a new common cognitive map on the problem in question, which helps them conceptually integrate the different orientations of their analysis. Despre's et al. (2004) understand that the difference between interdisciplinary and transdisciplinary approaches goes back to the prefix “trans” which denotes crossing the boundaries delimited by traditional monodisciplinary approaches. They make a distinction between what remains interdisciplinary because it does not generate a real exchange with other disciplines, but simply exposes its results from the disciplinary eye with which it was observed, while transdisciplinarity implies that the final knowledge accessed is not merely the sum of the disciplines that compose it.

However, an important limitation emerges when processing the information collected, since, due to the increasing specialization of researchers, there are rigid borders between various areas of knowledge, which make it difficult for them to interact with each other. Therefore, it is necessary to search for channels that connect the different areas of knowledge and research practices among them, to promote joint work, which results in richer approaches to the objects of study. In this sense, finding ways to concretize and mobilize these fields of knowledge through diverse social and cultural practices avoids fragmentation [Hermans & Hermans-Konopka, 2010]. The challenge lies in creating possibilities for participation and collaboration between different institutions and training profiles, between and across institutions [Akkerman & Bakker, 2011].

## **2. Objective**

The purpose of this article is to describe a transdisciplinary approach experience, to exemplify the data collection techniques used, the analysis tools; as well as the difficulties and opportunities that the team encountered in the process, the decisions taken and the results obtained from the research.

The article is structured as follows: background of the platform to be studied and theoretical framework that supports the study, description of the methodology used,

sampling frame and data collection methods design. Finally, are described the results of the experience and the conclusions obtained.

### 3. Background

Research in education with children is always a challenge for research teams. On the one hand, because due to their age it is necessary to follow a series of ethical procedures to preserve their identity, as well as authorizations from their adults in charge. On the other hand, if the study participants are inscribed on the formal educational system, there are also a series of administrative requirements, which demand the corresponding institutional permits to carry out the research. But beyond the ethical and administrative precautions necessary to develop research in education with children, there is also a methodological challenge: how to capture their attention with dynamics that involve them and motivate their participation, while at the same time being able to record their responses using data collection tools with which the data collected can be systematized and analyzed in an agile and productive manner.

This work describes the study carried out for the analysis of the Global Network Badges (GNB) tool, developed by the Global Learning Network (GLN) of Ceibal, educational agency of the Uruguayan state. The GNB are an incentive system for primary education students, aimed at offering rewards for their performance in the classroom through the delivery of medals that represent various figures from culture, science, and the arts; through which contents of the curriculum are channeled (Figure 1). In the specific literature, medals are recognized as badges, so from here on, for the purpose of this article, medals will be named as badges.



Figure 1 – Examples of badges that integrate GNB tool.

During the research, a methodological challenge arose of how to evaluate the students' appropriation of the concepts that the badges transmit. In this context, the possibility of constructing a questionnaire with gamified resources was discussed with the research team, to be applied with the participating students. The platform chosen was Kahoot due to its quality of being ideal for working with children given its playful, visual, entertaining, online nature and ease of use by both students and researchers when developing the questionnaire. Kahoot is an educational platform designed to build questionnaires, debates, surveys, exams, among other possible applications; in which students can interact from any device (mobile, PC, tablet), to participate in the challenges posed. But, in addition, Kahoot can be used as an evaluation tool since it makes it possible to save the answers of each student to compare them later. Likewise, using this potential, for the GNB project it was used as a data collection tool, since by storing the responses and offering a very well-structured systematization of the results, it is very useful for developing questionnaires to collect information.

As suggested by Magadán-Díaz, M., Rivas-García, J. (2022), gamification in classrooms is not a totally new method, but gamified mechanics have been integrated into Student Response Systems (SRS) constituting what is called Game-based Student Response Systems (GSRS) such as Quizlet, Socrative and Kahoot. Motivational aspects of GSRS include: competition, leaderboards, achievement badges, reward points, instant feedback; encouraging students to interact in a playful and participatory way. Wang & Tahir (2020) highlight the fact that Kahoot temporarily turns the classroom into a quiz show, where the teacher is the host and the students are the competitors. As the authors mention, the studies published about SRS highlight the improvement in classroom dynamics, the better disposition of students to solve problems during class time, the improvement in attendance rates, the more pleasant classroom climate, the best disposition to learning and evaluation. The great differential of Kahoot is its playful platform, which makes it a GSRS. Moreover, Casemiro & Costa (2023) highlight gamified strategies as a resource that has been introduced with increasing importance in recent times, to promote participatory learning and greater student involvement in classroom activities, since the use of games promotes active learning methodologies. As a result, greater students' attendance is reported, as well as a more interactive classroom feeling and improved motivation to participate in classroom activities.

Because the target audience of the research are children, but also adults, different data collection tools are used for each group. In the case of students, is used a data collection tool appropriate to their age: primary school. Therefore, the focus is positioned on a playful, gamified tool, capable of capturing their attention in a fun and entertaining way. When talking about gamification, by definition, it refers to the application of game logics to other contexts, with the aim of invoking the motivating and relaxing experience that playing provides [Hamari et al., 2014]. Likewise, there is broad consensus in defining gamification as a series of practices that seek to adapt elements of video game design to other areas of daily life [Deterding, S., 2011], with the aim of encouraging motivation and participation. Gamification is a booming field of study in recent years, because its logic has been incorporated into multiple aspects of daily life, far beyond the education of children or young people [Zichermann, G., & Cunningham, C., 2011; Sailer, M. et al., 2017]. The main virtue of gamified strategies is the effects they generate on motivation, encouraging students to interact in a playful and participatory way.

#### **4. Methodology**

The methodology was developed from a transdisciplinary perspective, with the purpose of linking different fields of knowledge to achieve a richer approach to the topic. But, above all, because according to the sources of information that were accessed, an approach from various disciplines was necessary, which allowed to be carried out an analysis that linked multiple tools, both qualitative and quantitative; from engineering, computing and social sciences. As mentioned by Gómez, I.M. & Ruiz, M. (2018), this approach allows problem solving from a non-dissociated, global and multidisciplinary vision. It is therefore a response to the atomization of teaching and approaches in unrelated subjects. For this study, transdisciplinary is considered to be those scientific and investigative processes carried out based on the joint intervention of participants from various scientific and knowledge fields, through a dynamic process that makes it possible to find solutions to different research difficulties through a methodological framework

based on exploration, the fusion of theories and instruments from diverse related scientific disciplines, which address phenomena from a multidimensional perspective.

#### 4.1. Data Collection Methods

The data collection methodology was focused on the analysis of the user experience through semi-structured interviews with teachers and playful dynamics through gamified experiences with students. Moreover, the usage data of the *Logros* platform was analyzed to link qualitative information with quantitative information about total of badges awarded, most popular badges, competencies and dimensions most worked on. In this way, the sources of data collection were the following:

1. Data from the badge platform (*Logros*)
2. Semi-structured interviews with adults
3. Gamified questionnaire for students

In first instance, the information extracted from *Logros* platform was used for an initial selection of participants. At this stage, a Data Science specialist extracted the information with BI tools, to obtain aspects such as the number of visits to the GNB site in *Logros*, which were the groups where the greatest number of badges have been awarded, which are the most used badges, whether they have been delivered only once or whether there have been several deliveries repeated over time, periods in which they are delivered, etc. The analysis of this information made it possible to map the use of GNB throughout the country.

#### 4.2. Sampling Frame

The selection of participants for the study was carried out through the crossing of two sources of information. On the one hand, visualization analytics from the *Logros* platform with the focus on the total number of awarded badges in each group of students. On the other hand, to complement the information obtained from the platform, qualified informants were recruited. In this case, they were the teachers who have used the tool, and the mentors of the GLN territory team, who work directly with classroom teachers throughout the country.

**Table 1. Sampling frame where the data collection field work was carried out.**

School	Province	Location	Grades	Groups
1	Maldonado	San Carlos	5th	5th A
2	Lavalleja	Minas (rural)	3rd y 4th	3rd - 4th (mixed)
3	Durazno	Durazno	5th, 6th	5th A y 6th A
4	Canelones	Barros Blancos	4th	4th A y 4th B
5	Soriano	Rodó	4th, 5th, 6th	4th, 5th, 6th
6	Flores	Trinidad	4th y 5th	5th A y B, 4th B
<b>Groups</b>				<b>12 groups</b>
<b>Students</b>				<b>211 students</b>

Based on a selection of the most powerful experiences, individual and semi-structured interviews were carried out with classroom teachers. During the interviews, was sought to obtain information about the knowledge they have of GNB, their involvement, motivation with the tool and the description of use experiences. In the case

of students, after having identified teachers who know and make active use of the GNB, was held data collection with their classmates.

Interviews were carried out by Social Sciences researchers, with training in conducting interviews, focus groups and collecting data from organic sources, such as body language and vocabulary. Interviews were recorded by a videoconference platform, to transcribe and analyze the results with Natural Language Processing (NLP) tools.

### 4.3. Gamified Questionnaire

For the students, were proposed group recreational activities, from which data was collected. Through Kahoot, an online application that makes it possible to build questionnaires, evaluations, surveys, etc., was developed a questionnaire with gamified elements. Kahoot was chosen because it is a tool that students know, that they use often, and that meets the requirements of being playful, visual, and capable of collecting and systematizing data in a way that facilitates its subsequent analysis. The questions were presented based on triggering images. These were the badges themselves, to evaluate if they recognize each one, what type of reaction the different characters generate, if they were able to identify the concepts of the GLN associated with each badge, etc.

Below is an example of a question:



Figure 2. Description of the elements from a question deployed at Kahoot.

Table 2. Total of questions and type of each one.

	Question	Type
1	Which of these badges did you receive?	Multiple choice
2	How did you receive it?	Survey
3	Would you prefer to receive it in paper or digitally?	Survey
4	How did you feel when you receive it?	Word cloud
5	When was delivered, did you tell anyone? To whom?	Word cloud
6	What do you think this badge represents - Eduardo Galeano	Multiple choice
7	What do you think this badge represents - Greta Thunberg	Multiple choice
8	What do you think this badge represents - Mafalda	Multiple choice
9	Order the badges, from the one you like most to the one you like less	Puzzle
10	Imagine you have to give you a badge to yourself. Which one would you choose, why?	Open question

Moreover, the use of this application is a useful method to observe and analyze the interactions between students with the game elements that the GNB facilitate. This

method favors a variety of approaches, icebreaking techniques, approach those who may be shy and remove the researcher from the center of attention, so that could be integrated into the group and goes unnoticed in the activities. Kahoot has its own characteristics that have made it a widely used tool in classrooms, due to its perfect inclusion in class environments and the ease with which educational content can be adapted to its game logics [Caraballo, Ana M. et al. al., 2017]. Another benefit of Kahoot is that it encourages participation while reducing the fear of making mistakes, which in many cases is what stops students from participating in class. In this way, trial and error processes are promoted, fostering students to actively intervene in the classroom [Navarro, G. M. 2017].

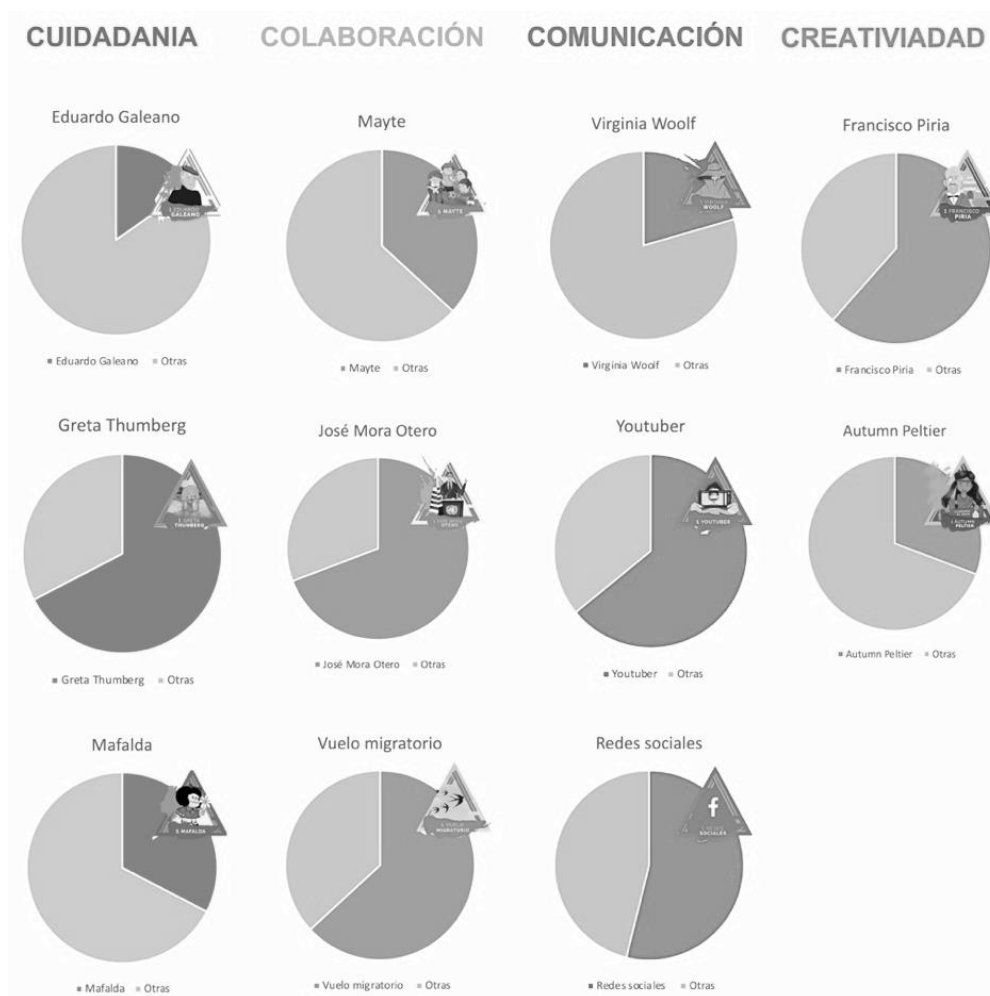
#### **4.4. Questionnaire Validation**

The validation of the instrument was carried out by applying the *Technology Acceptance Model 3* (TAM) based on the one developed by Venkatesh & Bala (2008). According to this model, there are 2 main determinants when adopting a new technology, these are: perceived usefulness (PU) and perceived ease of use (PEU). When adopting a new technology by a group of individuals, predicting their intention can offer valuable and accurate information for its implementation (Kriedeman, D. M. 2016). According to TAM model, these variables (PU and PEU) focus on the intention to use a technology, which results in its positive adoption. For real and effective adoption, those reluctant or innovative users must perceive that the technology is easy to use as well as useful to apply at their classrooms.

#### **5. Analysis**

The methodology of analysis obeys to the two large sources of data collected. Firstly, a quantitative analysis was carried out, based on the data produced by the gamified questionnaires applied through Kahoot. Secondly, a qualitative analysis was carried out through Text Mining and NLP. In the case of quantitative analysis, the first step was cleaning up the data extracted from Kahoot. A virtue of the application is that it has a very user-friendly data output, in which it performs an initial grouping and systematization of the results, depending on how the questions have been constructed. However, despite clear data output, data cleaning is necessary for subsequent analysis. For this purpose, data was grouped and segmented for later analysis, according to ages, gender, levels, which allowed to perform diverse approaches and find subtle nuances on the topic.

For the case of the correlation between the characters and the competency they represent, was asked the question: *What do you think this badge represents?* Figure 3 illustrates the frequency of right guesses, when showing the students, a badge and a series of options with what each one represents (See Figure 2).

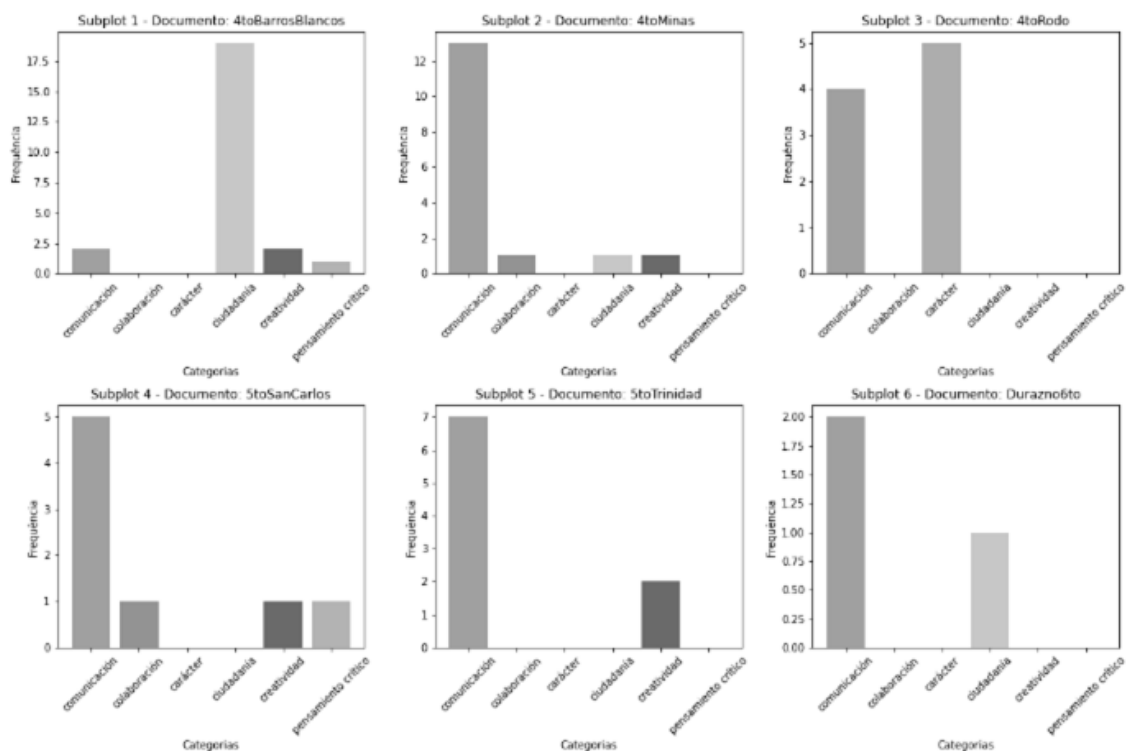


**Figure 3. Frequency of right guesses when students must recognize, from the image, the concept a particular badge represents, for 4th year students.**

At the same time, beyond the preference for badges from one competency or another, there are great differences between badges, even within the same competency. In some cases, the right guesses rate is high (above 50%), while in other cases it is quite marginal. As an example, it can be mentioned the badges of José Mora Otero, Migratory Flight, Youtuber, Social Networks, in the Collaboration and Communication competencies, among which they had a high right guesses rate. This approach is consistent with the overall results, since, among the competencies surveyed, Collaboration and Communication are by far the most clearly interpreted and remembered by the students.

Within the semi-structured interviews, these competencies emerged very often, especially the Communication competency. Below, the frequency of each of the competencies surveyed is presented in each of the interviews with teachers that were carried out.

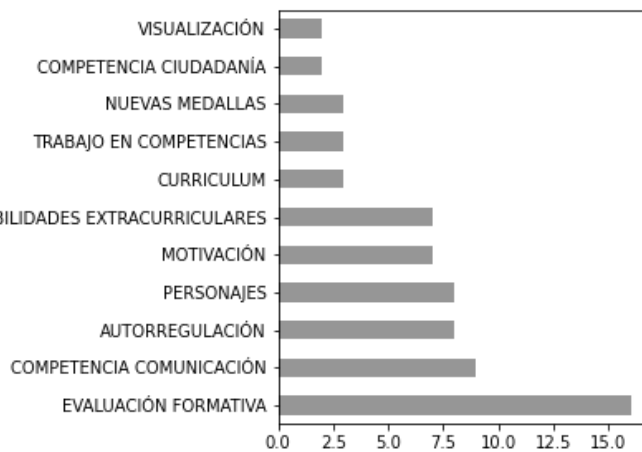




**Figure 4. Frequency of each competency in interviews with teachers.**

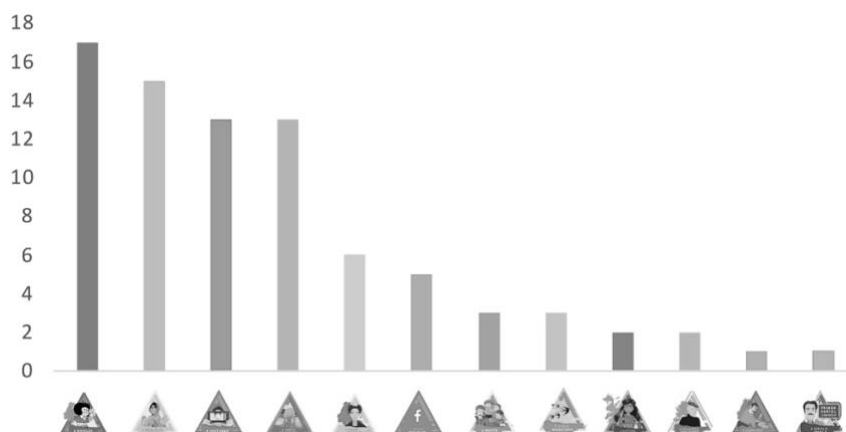
As can be seen, the Communication competency (first column) was mentioned in all cases and in most of them it is the one with the highest frequency by a wide range. In the case of the Collaboration competency (second column), its results are more marginal during the interviews, but, nevertheless, when analyzing the usage data taken from the *Logros* platform, its presence is important.

At the same time, to reinforce this point, during the analysis carried out using NLP, it emerged that along the interviews with teachers, the Communication competency is one of the most mentioned topics, only behind Formative Assessment (See Graph 1 below).



**Graph 1. Frequency of topics in number of times mentioned.**

The triangulation of the 3 sources of data collected (interviews with adults, gamified questionnaire with students, data usage from *Logros* platform) is consistent with these results and accentuates the preference towards Communication and Collaboration competencies.

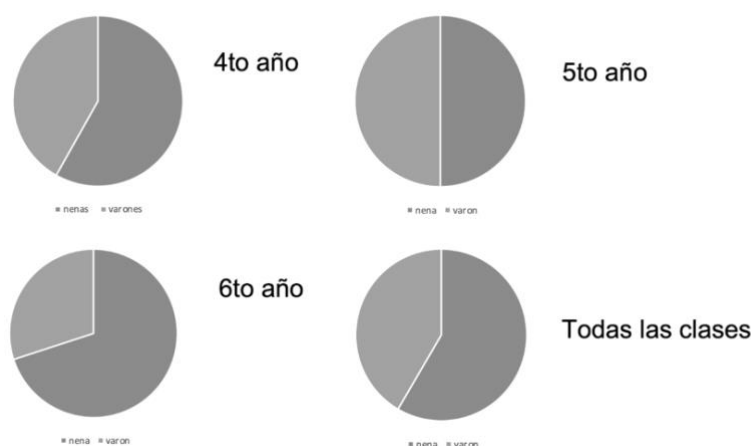


**Graph 2. Results of the question: *What badge would you award to yourself?***

Finally, within students, the results vary slightly, since the competencies chosen by youngsters differ from those chosen by adults. When asked: *What badge would you award to yourself?*, the five most chosen badges were Mafalda, Malala, Youtuber, Greta and Frida (Graph 2). Amid these there is none of the Collaboration competency and the Character and Citizenship competences are added, which were not among the teachers' preferences. This fact is significant, since it suggests that for the students, the figure of the character, their story and the daily link they have with their cultural consumption are stronger, rather than the concept they transmit, and not necessarily the content of the competency to which they refer. This is clear for the Youtuber and Social Networks badges, which are the most used, the most chosen by students and with which it is easier for them to identify what they represent. This is because, despite their age, these are elements that are part of their daily lives and with which they regularly interact.

To evaluate the students' appropriation of the concepts that each of the badges represent, was asked the question: *What do you think this badge represents?* (Figure 2). Figure 3 was created based on their responses. It shows that some badges have a better right guess rate than others. In this sense, several hypotheses arouse, which have to do with the fact that some characters are more linked to the daily lives of students, are part of their cultural consumption and therefore, they feel identified with them. In other cases, the choice is determined by the design of the badge, which awakens their interest and aesthetic taste.

In the case of the other badges mentioned (Mafalda, Malala, Greta and Frida), interpretation of the results has to do with the fact that the concepts they transmit are more accessible for their age and cognitive development than other more complex concepts associated with other competencies. This is because they transmit clear ideas, simple to assimilate and accessible to be channeled among primary school students.



**Figure 5. Distribution by gender, regarding preferences for female or male badges.**

As for aesthetic identification, some badges simply convey a taste for the character's design. However, a gender identification is also evident, since, when segmenting the preferences of girls or boys, when asked: *What badge would you award yourself?*, in the case of girls it is manifested a tendency to choose female characters as represented in the graphs of Figure 5, which shows the preferences for girls and boys grouped by grades 4<sup>th</sup>, 5<sup>th</sup>, and 6<sup>th</sup>. Last graph is the sum of all students, from all the grades, segmented by gender, which depicts the tendency for selecting female characters, in the case of girls.

## 6. Conclusions

From the analysis carried out, it emerges in the first instance that there are clear preferences, among both teachers and students for some specific badges, and even more so, for certain competencies. But as Martínez Miguélez, M. (2009) suggests, paraphrasing Werner Heisenberg, "we never observe the nature of things in themselves, but rather that nature exposed to our research method." In turn, this same physicist reveals that Einstein once told him: "the fact that you can observe a thing or not depends on the theory you use; it is the theory that decides what can be observed." These statements, purely epistemological, reveal the limitations and boundaries imposed by the research methods and instruments themselves, since it is from them that we can measure, evaluate, and approach our objects of study. For the case in focus of this research, the transdisciplinary approach provided diverse perspectives of analysis, which could not have been accessed from the approach of a single discipline. For example, the analysis carried out through Text Mining and NLP by computer scientists allowed to process a large amount of texts (interview transcripts) and establish patterns in them, finding recurrence of terms or phrases that provided certain biased or implanted visions in the interviewees, which made evident the presence of a common discourse in many of them. For this reason, recurrence analysis was carried out on isolated terms, 2 terms, 3 terms. This path did not yield significant results, since the mere existence of a term or a combination of terms in a discourse does not allow conclusions to be drawn about its origin. However, due to the time and depth of analysis that was achieved, it would have been desirable to delve deeper to know the source of said recurring discourse. Therefore, for a next foray that uses similar tools, methodological learning would be to be able to train an AI, based on legitimized

discourses on the topic of study, and then analyze its presence, partially or completely, based on terms or phrases, in order to evaluate the knowledge of the topic by the interviewees. In the case of in-depth knowledge, the discourse would be reflected in the specific terms or phrases used, as a replica of the legitimized discourse, and thus the theoretical adoption of the GNB tool by the interviewees could be verified.

Beyond the epistemological and methodological approach, the richest aspect of analysis is the interpretation of the reasons for the tendency towards the choice of certain badges or competencies. Among the students, it is stated that the character that the badge presents, their image, their daily bond, their identification with gender and even their aesthetic preferences, weighs more than the concepts that the badge transmit. This is evident in the choice of certain badges such as Youtuber and Social Networks, which were the most common at all grades studied and in different locations of the country. Furthermore, they are among those with the highest frequencies of right guesses, that is, they were clearly identified by the students, and even, when asking the students, *what badge would you award to yourself?*, they are also amid the most mentioned (Graph 2).

Saving the specific results, this article aims to reflect the advantages and even the need of transdisciplinary approaches in social sciences, since the power of computer tools that can be accessed and the analysis that can be carried out are only possible with specialists from diverse disciplines. Likewise, the exchange of specialized visions enriches and enhances the results achieved. This statement is confirmed by triangulating the 3 sources of data collected:

- *Logros* platform usage data
- Gamified questionnaire by Kahoot
- Semi-structured interviews with adults

to which a different approach was applied in each case. The platform usage data served to define the samples on which the interventions were made. The gamified questionnaire incorporated the conceptual content that was intended to be evaluated in the students, while the semi-structured interviews provided the vision of the adults. Nonetheless, each of them isolated is not enough to have a global vision on the subject. By crossing them and interpreting them under the magnifying glass of different specialties, it is possible to glimpse how new meanings emerge and how the results dialogue with each other.

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