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Design of an educational platform based on an innovative model of research in secondary school students

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ABSTRACT

The development of research skills worldwide is more emphasized in postgraduate programs; however, the training of these skills should be carried out from basic education; that is, from elementary school. In this sense, this research aims to formulate a proposal to develop research skills in secondary school students through an innovative model. The methodology was carried out through student surveys and interviews with teachers and authorities. The ATLAS.ti 22 software was used for network analysis and SPSS 23 for statistical analysis. The results obtained in the survey show that the dimensions of reading comprehension, writing and argumentation, academic writing, and scientific writing are within the acceptable average. However, in the interviews, some students show difficulties in scientific writing, but they show a critical position in their arguments. It is concluded that the authorities should incorporate the proposed model of research skills in the curricular plan, adding it to their annual plan; for this purpose, teachers should be trained to transmit it to their students. In addition, an innovative model is proposed during the 5 years of high school studies to develop students' research skills. The beneficiaries of the proposal are the entire educational community and therefore the country.

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1. INTRODUCTION

Globally, the education sector is facing new demands as a result of the progress of science and technology. Therefore, it is expected that educational centers will contribute to the solution of current problems in society. In addition, the health crisis resulting from the coronavirus disease 2019 (COVID-19) pandemic has reconfigured the teaching and learning model with the implementation of the virtual and hybrid modality [1]. For this reason, educational policies are being promoted worldwide to respond to this demand; however, we are far from achieving the objectives set. the regional comparative and explanatory study (employees reviews classification and evaluation (ERCE) 2019) conducted by the United Nations Educational, Scientific and Cultural Organization (UNESCO), states that Latin America and the Caribbean are experiencing a crisis in education, which affects the achievement of basic learning [2].

Among the fundamental skills of education, basic research skills should be highlighted, since they enable the development of meaningful learning. However, these have been limited to higher education and

are poorly developed at the middle or high school level [3]. Formative research is a constant need that in the last decades has acquired greater relevance in the Peruvian context; mainly at the university education level. In addition, there is a university requirement that students acquire basic research skills before entering university life. However, regular basic education (RBE) is curricular designed through competencies that do not directly correspond to the demands of higher education centers; that is, there is a gap between RBE and university education. Likewise, the graduate profile of secondary school students depends on the proposal of the national curriculum design (DCN). Accordingly, secondary schools develop adaptations with 30% in content, as well as in areas that can be incorporated into the school's educational proposal. The Ministry of Education of Peru has incorporated research skills into the national curriculum for basic education, aiming to develop critical and reflective competencies in students. Although implementation faces challenges, such as insufficient specific training for some teachers and a disconnect with university curricula, it is essential for promoting active and participatory learning. Strategies like problem-based learning and project-based learning have proven effective in strengthening these competencies at the secondary education level [4].

On the other hand, in the educational environment there is no evidence of models and/or didactic strategies at the upper secondary level that are aligned to form research competencies and at the same time develop research and the production of scientific articles with critical thinking [5], [6]. In addition, there are no teachers with experience in teaching the subject and who have consolidated a research process. The study of research skills in secondary education provides a hinge base for higher education at the university level. In addition, the educational platforms of an innovative model will allow students and teachers to interact optimally in all phases of research from first grade through fifth grade. In this way, it contributes to mitigate the technology gap in the research part. The importance of students knowing how to use the technological tool in the different levels of study allows the progress of their research skills. In this way, students are more creative, innovative and critical; and thus, they can contribute and contribute to the development of their society [7]. Formative research in education refers to a type of research whose main objective is to improve or develop educational practices. Programs or policies through data collection, analysis and application of findings. Unlike pure academic research that seeks to generate new theoretical knowledge, formative research is oriented towards action and continuous improvement in the educational context [8]. It also involves different actors within the education system, such as students, teachers, principals, administrators and parents. Feedback from these participants is critical to understanding problems from diverse perspectives and finding effective solutions.

In this context, schools must implement a curricular program that contributes to shortening the distance between secondary education and higher education through an innovative proposal, specifically in the area of research. In this sense, the Bertolt Brecht School under study promotes the development of research skills that extend to all levels of regular basic education and constitutes an important axis of its educational proposal. The curricular areas that consider the development of research skills are science and technology, social sciences, mathematics and communication. Based on the experience and evaluation of the development of research skills at the Bertolt Brecht School, we can point out that, at the primary level, research skills show difficulties in the acquisition of basic research skills by students, which could be associated with problems in the curricular articulation processes. About the learning results of 4th and 5th grade high school students, obtained from the application of an evaluation instrument, it is shown that in the competency "Investigates through scientific methods" (problematizes, records and analyzes data, communicates their findings), students do not achieve 35% of the skills that are considered basic abilities for the development of research competencies. In the competency "Reads diverse types of texts" (obtains information from the text, infers and interprets, reflects and evaluates the text), students do not achieve 31% of the capacities. Likewise, it is perceived that students show greater difficulty in the comprehension of scientific texts. Regarding the competency, of "writes various types of texts" (adapts the text, writes, uses resources, evaluates the text), students do not achieve 42% of the competencies. In the competency "solves problems of data management and uncertainty" (represents data with graphs and statistical measures, uses strategies and procedures to collect and process data, communicates an understanding of statistical concepts, sustains conclusions based on the information obtained), students do not achieve the competencies in 65%.

From the above, it can be inferred that 4th and 5th year high school students have difficulties in achieving basic research skills, which becomes an obstacle to the development of complex skills. Therefore, the Bertolt Brecht School has decided to implement an educational platform that allows the academic and scientific writing course to contribute to the development of research skills with critical and creative sense from the writing of scientific articles, which will be disseminated to the educational community and to various environments in the field of research. This study is based on the question: How will the application of an educational platform design based on an innovative model for the development of research skills influence the training of students at the Bertolt Brecht School? The objective of this research is to design an educational platform based on an innovative model for the development of research skills in students of the

Bertolt Brecht School. For this purpose, an exhaustive analysis of the problem in situ of the research to be carried out was initiated. In this way, benefiting the educational community.

2. LITERATURE REVIEW

Explaining In this section, an analysis was made of the study of research skills in secondary schools carried out by different specialists at the international, regional and national levels to have a broad overview and to know what limitations, gaps and trends have been presented in these investigations. In this way, it is possible to find out what methodologies they have used, the results obtained and the conclusions they have reached; this holistic view will allow a more objective analysis. Regarding the development of research skills, these are not necessarily formed at higher levels; although it can be affirmed that it is at this level that there is greater awareness of these competencies; these, to a large extent, are acquired in regular basic education.

Among the studies on research skills in elementary school students, those oriented to the literature review on conceptual orientations are presented. In this sense, the research by Huaman [9] proposes to approach the study of scientific thinking of secondary school students at the international level. All this to systematize the research perspective from a theoretical as well as conceptual approach. For this purpose, an analytical review has been carried out to map most of the bibliographic information published in the Redalyc, Scopus and Web of Science databases during the period 2011-2021. The results show the relationship between three conceptual approaches: the political perspective, the pedagogical-didactic perspective and the philosophical perspective. Likewise, eleven thematic areas are suggested, which reveal the interest in secondary education to implement and put into practice this way of thinking and strengthen the development of skills, abilities, attitudes and competencies through pedagogical and didactic strategies in line with the political and curricular guidelines, which allow the acquisition of general and particular knowledge of science, through research skills; as well as for the construction of a scientific model and culture. It is concluded that this development of thinking is important to meet the social, political and ethical needs of high school students and to study new forms of curricular development from an interdisciplinary perspective.

On the other hand, studies have been conducted on the development of scientific or research skills at school. Among them, we can mention Salamanca *et al.* [10] who argues that both generic and technical investigative skills can be developed in regular basic education. However, generic skills are influenced by the collegial practices that students have to address their school or course assignments, such as fulfilling research tasks based on the teacher's demand. The study used the quantitative-qualitative method, which allowed it to analyze the students' responses and extract the respective categories that guide their perceptions about the course: high degree of complexity, boring and laborious. The study concludes that the approach or model to develop the course for this educational level has to pay attention to didactic teaching strategies that strengthen generic research skills associated with motivation, interest and attitudes towards research, as well as interdisciplinary and collegial work among teachers.

In addition to these studies, some have taken into account the new educational scenario generated during the COVID-19 health emergency, which has influenced the development of research skills. The study conducted by Marviyani and Erman [11] on the application of science learning in secondary school through the case study method directed to 5 science teachers and 15 students from 3 secondary schools in Watulimo, concludes that the learning of skills in the science process during the COVID-19 pandemic was diminished mainly in hypothesis statement, data interpretation and experiment development. This is because online learning results in many students not responding immediately to activities, time is shorter compared to face-to-face education, and students' backgrounds are diverse. In addition, teachers have not been able to incorporate in their materials and worksheets material on science process skills.

Likewise, the research conducted by Sabirova and Zakirova [12] sought to verify the pedagogical conditions in the formation of research skills in elementary school. In this study, 211 students and 9 teachers of primary education from three schools of Kazan in Tatarstan, Republic of the Russian Federation, participated. For this study, extracurricular activities were introduced to teach research skills to the younger ones. The results showed the influence of the pedagogical potential of the school on the formation and development of skills in students at the stages of adaptation, mastery and self-realization.

To determine the characteristics of the scientific process skills of high school students. The study conducted by Harja and Sinaga [13] shows that the average obtained by students of a high school in Tapaktuan (Indonesia) regarding research skills is very low. The research is qualitative descriptive and the multiple-choice test was applied to assess these skills and concludes that students at the secondary level failed to excel in the high category (0%); in the intermediate category, only 25% and in the low category 75%. The main deficiency is found in the skills of asking questions, planning experiments and applying concepts; while in other categories such as observation, hypothesis or selection of variables they do achieve enough. In summary, scientific skills are still low, only reaching an average of 48.9%.

About this, Sunyono [14] conducted a study with 9th grade students of 2016/2017 academic year in Indonesian students where 120 students were randomly surveyed. The results showed that scientific process skills in provincial students are low for all indicators (observing, classifying, predicting, interpreting, and communicating). Besides, the research conducted by Novitasari and Aminatun [15] aimed to analyze the scientific process skills of public-school students in Kebumen regency about the topic of environmental pollution. The sample consisted of 150 students of class XI in SMAN Kebumen regency and the form test technique with essay type questions was used. From the study, it was found that the students' scientific process skills for the classification indicator obtained 70.12%; 56.75% for the drawing conclusion indicator; 66.5% for the drawing conclusion category and for the predictive indicators 67.75%.

On the other hand, some studies in this field show experiences in applying programs and activities for developing scientific research skills at school focused on scientific writing. In that sense, the causal-comparative study conducted by Palines and Cruz [16] aimed to examine the scientific literacy of high school students of a National High School in the Philippines under the science, technology and engineering program (STEP). More precisely, the study investigated the factors that facilitate and hinder students' ability to write and present scientific investigations. The results show that scientific literacy, in terms of writing, is perceived as good; however, the presentation of scientific research was perceived as fair. In addition, the study highlights the influence of other factors such as teacher, learning environment and administrative support on the development of scientific literacy skills.

Another interesting experience was developed by Zer-Kavod [17] which aimed to design and examine a teaching and learning environment based on adapted primary literature called "SWIM," which stands for "Science writing interactive model." The aim is to promote the scientific writing skills of biology students in a high school in Israel. The study focused on a program design-based methodology consisting of four phases: the first phase focused on recognizing students' difficulties in inquiry-based writing in biology class. In phase II, the principles were defined and the teaching-learning environment was designed. The implementation of the interactions was carried out in phase III. In phase IV, the results of the design were evaluated and recommendations were elaborated. The results of this experience indicate that students lack the genre knowledge required to write an inquiry project report. Also, teachers present difficulties in teaching scientific writing. Students focus on the content and not on the genre of the article, which is not sufficient for the development of scientific writing skills. From the design and implementation of this instructional model, it can be corroborated that knowledge and experience are distributed and shared among the teacher, students and the program, which enables the learning process and eventually the socialization of students in ways of knowing and understanding within the discipline. Likewise, the teaching of writing strategies and self-regulation procedures should be taken into account.

In Peru, universities are required by law to follow strict guidelines on fostering research. As a result, research has become an indispensable element of professional education. This article highlights the techniques a private institution in Lima has employed to enhance the research skills of its engineering students [18]. The virtual availability of young and experienced researchers, full-time professors, and academic authorities has made this procedure possible. These initiatives have simplified research project completion for professors and students whose works are indexed in Scopus, enabling thesis progression.

The global education industry faced challenges amidst the pandemic. To address these issues, measures were implemented to facilitate the seamless launch of virtual classrooms and equip educators for this new environment. A teacher training paradigm was devised, utilizing virtual courses with a focus on asynchronous instruction [19]. These courses cover various topics such as lesson planning, pedagogical resources, assessment tools, curriculum design, and teacher induction. These prototypes were developed for future use and underwent initial analysis, a model proposal, validation by education technology and pedagogy specialists, as well as a survey that was approved by 85.5% of respondents.

Peru's University Statute 30220 mandates research centers for universities to be licensed and accredited. A study proposes an inventive approach, connecting computer and systems engineering student research to the accreditation process. Fifteen stakeholders were interviewed using the Maltese cross and soft systems techniques, and ATLAS.ti 22 analyzed the data [20]. Ninety-two and a half percent of experts who evaluated the suggested model agreed that it was clear, coherent, and relevant. The approach of integrating research courses from the first to the last semester can enhance the quality of education when implemented in other universities.

Students perceive math as difficult because of the way it is often taught in universities. However, the inverted classroom approach can change this view and improve instructional strategies. Research on elementary math at a university in Peru utilized this approach, comparing its effects between 227 pupils (the experimental group) and 215 students (the control group). Academic performance and attitudes towards mathematics were evaluated at important points throughout the course [21]. Substantial differences between the groups were identified through statistical tests conducted on the data, thus demonstrating the effectiveness of the inverted classroom.

In summary, the authors focused their research on three main lines of study. On the one hand, there have been studies that theorize on the currents and theories of scientific thought. Secondly, studies that are interested in determining the research profiles of secondary school students, and finally, studies that present significant experiences in the development of research skills in certain subjects. From this, it can be corroborated that the studies focus mainly on international experiences such as Europe and Asia; however, there is a lack of studies at the regional and Peruvian levels. In addition, there is no educational and curricular proposal for articulation between the secondary and higher education levels, in terms of the development of research skills. For this reason, the present study focuses on the proposal of an innovative model for scientific writing in secondary education to contribute to the educational sector at the national and regional levels.

3. METHOD

The research will adopt an exploratory and descriptive non-experimental design, incorporating a mixed qualitative-quantitative methodology. The mixed methodology integrates qualitative and quantitative research methods, enabling a more comprehensive understanding of a research problem. By using this approach, researchers can address complex issues from different perspectives, which broadens and deepens the findings [22]. This approach entails in-depth exploration and interpretation of data alongside the collection and analysis of numerical data to comprehensively examine the research topic. By combining these methods, the study aims to provide a well-rounded understanding, considering both qualitative nuances and quantitative trends. This approach will allow for a more holistic investigation of the subject, facilitating a thorough exploration and comprehensive insights into the phenomenon under study.

3.1. Population and sample

The research is centered on a population comprising high school students in their fourth and fifth years of study, targeting an age group typically around 16-18 years old. A sample size of 250 students from these specific grade levels was chosen to participate in the study, allowing for a representative subset of the population to be examined. This sampling approach ensures that the research findings apply to this particular segment of high school students, providing valuable insights into their experiences, attitudes, and behaviors [23].

3.2. Instrument construction

The research consists of two moments for which two instruments were constructed. In the first quantitative part, a questionnaire was developed to measure research skills, which consists of three dimensions: reading comprehension, writing and argumentation, and academic and scientific writing. On the other hand, for the qualitative research, the instrument used was an interview guide. The analysis of this part was carried out with the ATLAS.ti 22 program, which was constructed by categories. The questionnaire was carried out at the school's facilities, during the class sessions of the scientific writing I and II course. The students were given a brief introduction to the objective and characteristics of the questionnaire [24].

3.3. Validation and reliability of the instrument

3.3.1. Validation

It was analyzed by criteria where relevance will be (R) coherence (CO) and clarity (C) applying Aiken V coefficients; for this, it must be obtained greater than 0.80 for its approval. Only items greater than 0.90 and less than 0.80 were placed for analysis [25]. Table 1 shows that most of the items obtained a mean greater than 0.80, which suggests that the experts considered these items to be relevant and adequate to measure reading comprehension in the areas evaluated; in this case, the item with the highest score is “You use reading strategies (underlining and margin notes) for text comprehension” with a mean of 0.97. This indicates that the experts considered this item to be very relevant and adequate for measuring reading comprehension in that area. However, the item “Can you establish synonyms, antonyms, analogies, and metaphors for specific terms you have extracted from the reading” obtained a mean of 0.75, indicating that the experts considered that this item may have some limitation in its ability to measure reading comprehension in that specific area accurately. Overall, the results support the validity of the items in the reading comprehension test, although additional revision or adjustments to the item with a mean below 0.80 could be considered to improve its validity. It is important to keep in mind that the results are based on expert judgment and that the interpretation should consider the opinions and knowledge of the experts involved in the validation.

The results obtained in Table 2 indicate that the participants demonstrated a high level of competence in these areas since the item means are between 0.90 and 0.94. This means that, on average, participants showed a good command of the organization of ideas, compliance with grammatical and spelling

rules, construction of solid arguments, use of effective counterarguments, and adequate structuring of argumentative texts. In addition, participants also demonstrated revision and proofreading skills, as attention was paid to coherence, cohesion, spelling, citations, and the use of reliable sources. These results suggest that those evaluated are capable of writing quality academic texts, taking into account both form and content. In this sense, the scores obtained in the dimension of writing and argumentation reflect a good level of competence in key aspects of academic writing, which indicates that the participants can organize their ideas effectively, use solid arguments and maintain high standards of linguistic and structural quality in their argumentative texts.

Table 1. Reading comprehension dimension

Items	R	CO	C	Mean
You identify the central theme and subthemes of a text.	0.89	0.93	0.93	0.92
You use reading strategies (underlining and margin notes) for text comprehension.	0.96	0.96	1	0.97
You identify the main and secondary characters in the story.	0.96	0.89	0.93	0.92
You are able to draw conclusions about the reading.	0.93	0.89	0.89	0.90
You can raise questions from the reading.	0.89	0.96	0.93	0.92
You can establish synonyms, antonyms, analogies and metaphors for specific terms you have extracted from the reading.	0.78	0.74	0.74	0.75

Table 2. Writing and argumentation dimension

Items	R	CO	C	Mean
You organize the ideas in your writing by paragraphs.	0.93	0.89	0.89	0.90
You consider grammar and spelling rules in your academic texts.	0.93	0.93	0.93	0.93
You support your ideas using clear and coherent arguments that allow you to defend your thesis.	0.89	0.93	0.93	0.92
You use counterarguments to support your position.	0.96	0.93	0.93	0.94
You write in an orderly manner the sequence of an argumentative text (introduction, development and conclusions).	0.93	0.93	0.89	0.92
You check the coherence, cohesion, spelling, citations and use of reliable sources in the writing of your argumentative text and make the necessary corrections.	0.93	0.93	0.93	0.93

The validation of the academic and scientific writing dimension was carried out considering different items related to specific skills in this area. The results show that most of the items obtained means above 0.80, indicating that they were considered valid and adequate to measure these skills. However, it is important to note that one item obtained a mean of 0.74, indicating that the experts considered that this item may have limitations in terms of its ability to accurately measure the corresponding skill.

As for the other items, the results are positive. A high mean of 0.93 is observed for the use of APA norms, which indicates that students are competent in their application. Likewise, the use of references and citations in the writing of scientific articles obtained a mean of 0.94, suggesting that students demonstrate skills in this aspect, as shown in Table 3). On the other hand, the use of different forms of quotations (textual, non-textual, paraphrasing) obtained a mean of 0.90, which indicates that students have an acceptable command in this aspect. However, it is important to consider that there is room for improvement. The statistical interpretation performed in the course obtained a mean of 0.78, suggesting that students may encounter some difficulty in this area and could benefit from further skill development.

Table 3. dimension academic writing and scientific writing

Items	R	CO	C	Mean
You feel prepared to search for information.	0.74	0.74	0.74	0.74
You use APA guidelines for the writing of your texts.	0.93	0.93	0.93	0.93
You use references and/or citations when writing your scientific article.	0.96	0.93	0.93	0.94
You use different forms of quotations (verbatim, non-verbatim, paraphrasing).	0.93	0.89	0.89	0.90
You interpret without difficulty the statistics performed in your course.	0.78	0.78	0.78	0.78
You have mastered the complete structure of a scientific article.	0.81	0.78	0.78	0.79
You write fluently the conclusions of your research.	0.93	0.93	0.93	0.93

Regarding the completion of the complete structure of a scientific article, students obtained a mean of 0.79, indicating that there is still room for improvement in this aspect. Finally, the fluent writing of research conclusions obtained a high mean of 0.93, indicating that students have outstanding skills in this area. In that sense, it can be said that the results suggest that students show strengths in some academic and scientific writing skills, such as the use of APA norms, references and citations, as well as the fluent writing

of conclusions. However, some areas could benefit from further development, such as interpreting statistics and completing the full structure of a scientific article. These results provide valuable information for the development and improvement of student's academic and scientific writing skills.

3.3.2. Reliability

The reliability coefficient of an instrument, also known as Cronbach's alpha, is used to evaluate the internal consistency of the questions or items in a scale or questionnaire; its value being greater than 0.70 for approval. This coefficient varies from 0 to 1, where a value closer to 1 indicates greater reliability [26]. A value of 0.973 was obtained for the fourth year and 0.942 for the fifth year. These values are high and exceed the recommended threshold of 0.70 to consider the instrument reliable. The interpretation of these results indicates that the questions or items of the instrument used in the fourth and fifth years of high school are highly consistent with each other, which implies that they accurately measure the variable or construct they seek to assess. This high reliability suggests that the responses obtained from the participants reliably reflect the variable of interest.

4. RESULTS

4.1. Analysis of the interview

The coding processes used in the qualitative analysis are outlined to provide clearer context to the results, such as the teachers' textual responses and the graphical representations. The responses were analyzed using open coding, a method that involves a thorough examination of the data, conceptualizing and categorizing the observed phenomena. Figures 1, 2, and 3 illustrate the results of selective coding, where the categories identified in the previous stage are integrated and refined to create a more coherent and simplified coding scheme. Figure 1 shows the reading comprehension category made up of the subcategories inferential, literal and critical reading. Likewise, the relationships among its elements allow us to have a broader view of the interview conducted. A contradiction observed is that students use resources such as annotations, and underlining, among others; however, it is observed that they do not use them strategically. In addition, it is in the inferential area where the students present more difficulty [27].

D6: One of the areas where they are lowest is in understanding and production, so these are aspects that we need to work harder on. The issue of understanding is, generally, inferential is where it is most difficult, for children to be able.

According to the information provided, it is observed that one of the areas where students present the greatest difficulty is in the comprehension and production of texts, specifically in the inferential area. This means that they struggle to make inferences from the information they read, which limits their ability to fully understand the text and produce quality texts of their own. Iraola-Real *et al.* [28] also expresses the importance of interpreting texts from regular basic education since in this way they develop their skills and abilities as a basis for future research.

D7: Now, in terms of text comprehension, where we have seen in recent years that students have had greater difficulty in questions at an inferential level, deduction questions.

D10: Another difficulty that has also been evident is that they still present problems when inferring, deducing.

The teachers' comments agree that students have difficulties in inferential understanding of texts. Specifically, it is observed that they have difficulties making deductions and inferences from the information in the text. This means that it is difficult for them to go beyond what is explicitly expressed in the text, which limits their ability to fully understand the meaning of the text. The development of the student's inferential understanding occurs when they use the ideas and information provided in the text, combined with their personal and intuitive experience, to formulate hypotheses or assumptions about the topics they are reading [29].

D10: However, some difficulties have also been identified, for example, when organizing their ideas or making summaries, concept maps, visual organizers with the information from the text, it is evident that the majority of students still copy the entire paragraph or complete sentences to deal with to summarize; However, it is known that they should establish keywords so that they can, in this way, better understand the text.

Likewise, students also have difficulties organizing ideas logically and coherently in a text. They fail to identify the main ideas and express them in their own words, which affects the quality of their writing. Additionally, they do not understand the use of tools such as concept maps to organize information in the text. On the other hand, there is a tendency to copy verbatim from the original text when making summaries or concept maps. This indicates that students are not processing the information deeply and are not using their own words to express the ideas in the text. Students face a significant challenge in the area of reading comprehension, especially in the inferential area. This area of language presents obstacles for them to make inferences and deductions from the information present in the text, which considerably limits their ability to fully understand it and produce quality texts. In addition to difficulties in inferential understanding, students also experience problems organizing their ideas logically and coherently, which negatively impacts the quality of their writing. Added to this is the ineffective use of reading strategies such as underlining and note-taking, which are not used strategically, which further limits their understanding of the text. Several experts agree that the coordinated use of multiple strategies, such as underlining, annotations, hypothesis formulation, reflection, and summarizing, improves the understanding of argumentative texts. They emphasize that the combination of these techniques facilitates the identification and analysis of the textual superstructure, favoring the approach to such texts [30], [31]. Finally, it is observed that students have difficulties summarizing and creating concept maps. Instead of processing the information and using their own words, they tend to copy the original text, which shows a lack of deep understanding of the content.

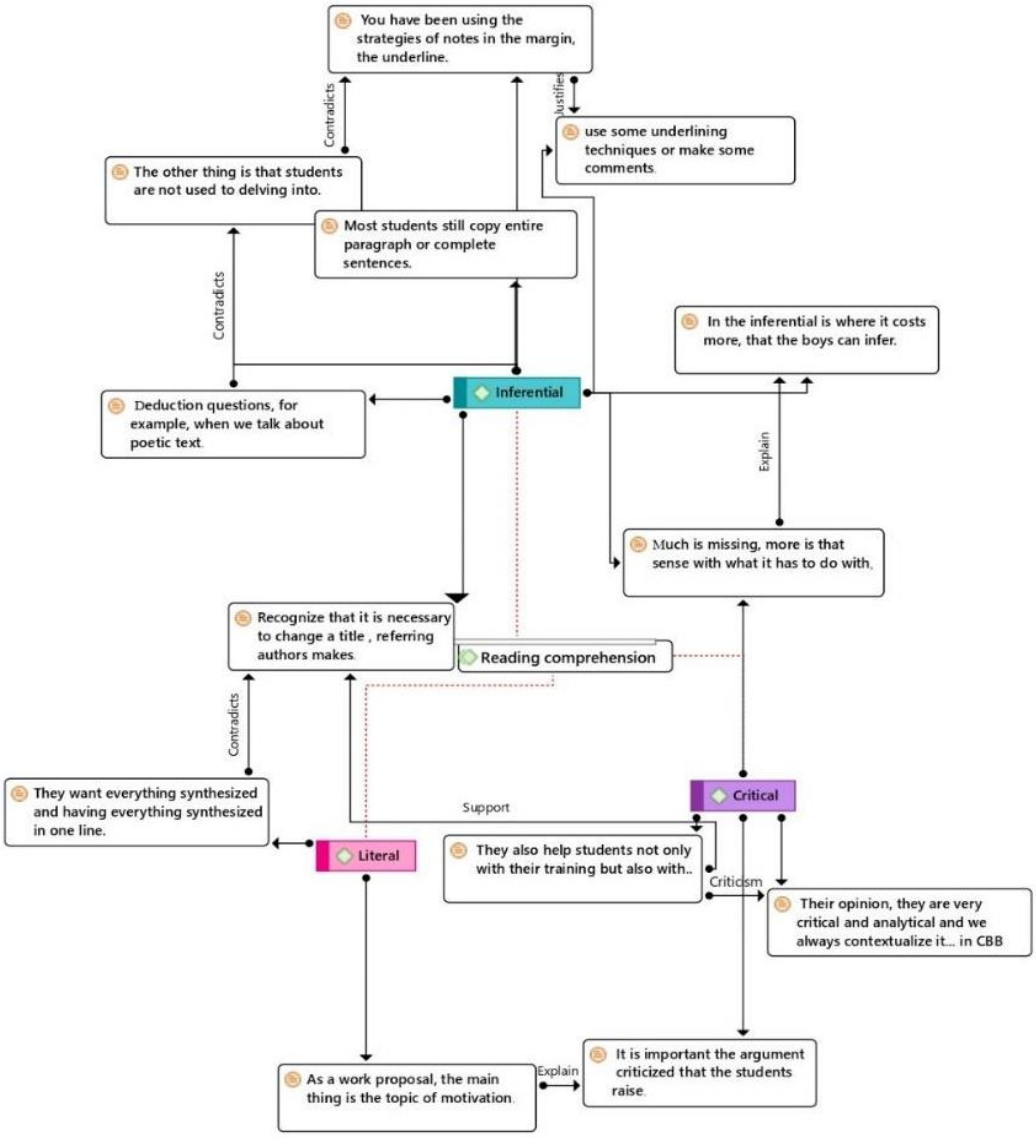


Figure 1. Reading comprehension

Figure 2 illustrates the category of writing and argumentation, comprising the subcategories of writing and argumentation. Within this category, there is still a noticeable need to strengthen spelling, proper writing skills, and the application of techniques to develop them. Additionally, in terms of argumentation, some students have partially developed their argumentative skills. However, some students encounter difficulties in presenting arguments and counterarguments effectively. The goal of a counterargument is not to defend one's perspective but to challenge that of the other. The speaker must consider the other's opinion as unacceptable and believe that they have solid arguments to contradict it [32].

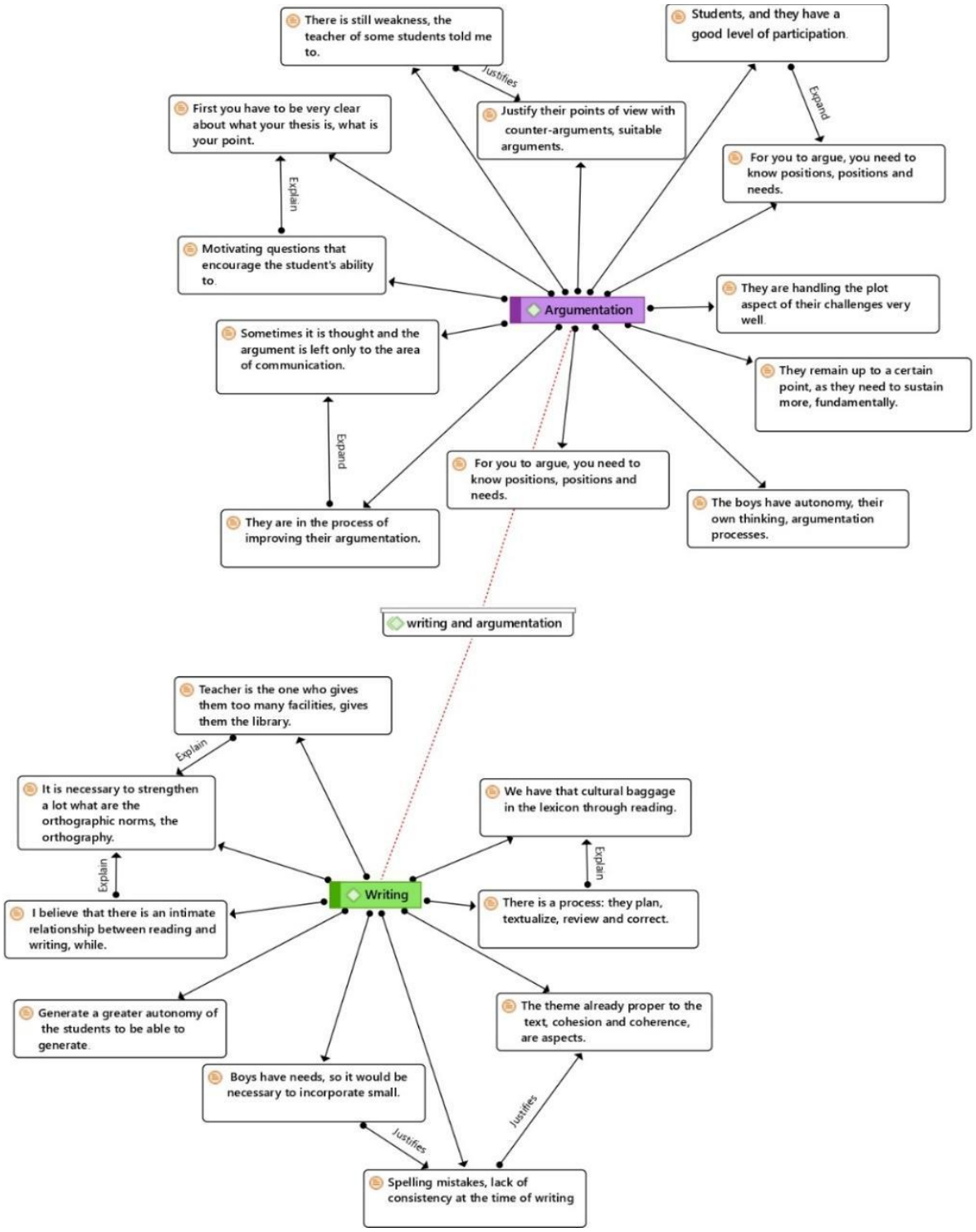


Figure 2. Writing and argumentation

The category of writing and argumentation stands out as a pivotal area for the development of communication skills. This category, divided into subcategories of writing and argumentation, reveals a persistent need to improve fundamental aspects such as spelling and the ability to write effectively. It underscores the importance of implementing specific techniques that allow students to develop these skills more solidly and coherently.

Regarding the subcategory of writing, it is evident that some students still face challenges in structuring and expressing their ideas clearly and coherently. This highlights the importance of promoting writing practices that encourage textual cohesion and proper organization of information. Additionally, there is a need to provide individualized feedback that addresses specific areas for improvement in each student's writing.

On the other hand, in the realm of argumentation, there is a range of skill levels among students. While some demonstrate partial mastery in constructing solid arguments, others struggle to structure and defend their ideas convincingly [23]. This underscores the importance of offering educational activities and strategies that strengthen argumentative skills, such as identifying relevant evidence, logical argument structure, and the ability to counter-argue in a grounded and respectful manner.

D6: In that sense, I think that something that has been implemented last year by being able to incorporate this scientific writing course has meant that the kids can also wake up to what a matrix is, what variables are, and they have included more language. and they have been nourished by that, but perhaps they have also seen it as very complex and when they see it as very complex. […] two things happen: either we reject it outright because we say I am going to fail here or I see it as a challenge.

D8: The progress of the students is that they are creative, they follow the didactic processes in terms of production, they carry out planning, they are very motivating in this. But there is still a need to reinforce, for example, in the sequence and coherence of their ideas when writing, the logical order in grammar, for example, also to reinforce these spelling resources, although they manage the spelling rules, they still need to reinforce them.

Texts D6 and D8 agree that students need to improve their writing skills. One of the teachers highlights the importance of the scientific writing course for students to understand concepts such as matrix and variables, and for them to expand their vocabulary. However, some students might find the course complex, which could lead them to reject it or view it as a challenge. On the other hand, specific areas were identified in which students need to improve, such as the sequence and coherence of ideas when writing [29], logical order in grammar, and the use of orthographic resources.

D9: In the revision and correction, although it is true there is progress, but deficiencies with respect to spelling, using connectors well, and punctuation marks, there are very few students who do manage adequate writing, but many still have many disadvantages.

D10: However, some difficulties also arise, such as spelling errors even in secondary school, also in terms of the cohesion of the ideas they must have, the use of punctuation marks, knowing when an idea is finished, knowing when We must suddenly use the comma, the semicolon, so that it can have much more sense and precisely cohesion and coherence in terms of the text; Those are the main difficulties.

Comments D9 and D10 reveal that the writing of students, both primary and secondary, presents deficiencies in various aspects. There is a high frequency of spelling errors, inadequate use of connectors to connect ideas, difficulties with punctuation and poor writing in general, with poorly structured sentences and lack of clarity. Furthermore, the texts are not always cohesive and coherent, which makes understanding difficult. The use of connectors as common tools to unify discourse and initiate new paragraphs can present certain challenges [33].

D3: *Regarding the development of argumentative skills, I consider that there is progress, I have been able to listen to the support that the students make due to the internal debate contest that was held at the headquarters, and we do have students who have begun to use bibliography, content diverse and from this they present their ideas, contrast them, develop their conclusions, considering positions or various sources.*

D10: Well, in terms of argumentation, especially in the fourth and fifth grade students, there has been much more confidence when presenting their ideas, establishing their positions and in some cases the students even quote while we are having the conversations, they quote to some authors, they cite some quite

relevant passages that support their answers, suddenly you no longer see the simple or basic answers of the students based merely on their opinion, you see that there is a research topic in this sense.

Comments D3 and D10 agree that students' argumentative skills have progressed. It is observed that students participate in debates, use a bibliography and diverse content to support their ideas, contrast them and draw conclusions, considering different positions and sources. In addition, fourth and fifth grade students are more confident when presenting their ideas, they support their answers with quotes from relevant authors and passages, and a higher level of research is observed in their answers. Students can detect errors in aspects such as spelling, accentuation, and grammar, as well as in textual coherence and cohesion. These aspects represent a more advanced level of analysis and reflection, allowing them to develop metacognitive processes [34].

D5: There is still weakness (in the development of argumentative competence) the teacher told me that some students have problems expressing or substantiating their ideas, and this is also because it is not a job of one or two years, but it is a job, as has been well proposed, from the first grades respecting the levels of development in each of them.

This text highlights the persistent weakness in the development of argumentative competence among some students. The teacher points out that some students experience difficulties expressing and substantiating their ideas, which is attributed to the continuous nature of the learning process, emphasizing that the development of this competence is not limited to one or two years, but requires constant work. from the earliest grades, respecting the rhythms of individual development.

Also in Figure 3, the category academic and scientific writing is shown with the subcategories academic writing and scientific writing. In this category, students have difficulty reaching this level, which is the highest level of student research. The search for information in reliable sources, and paraphrasing in scientific writing, are the greatest difficulty expressed by the students.

It has been observed that students have difficulties in the process of argumentative textualization (PTA) because the majority are at the initial level. This is due to their lack of knowledge about the structure of an argumentative text, such as the title, introduction (thesis), development, conclusions, and bibliographic references. Additionally, contradictions and a limited use of cohesion mechanisms were found in their writings [35].

D10: I have been able to perceive that, above all in the areas of science (biology, chemistry), students are quite clear about what the formulation of a hypothesis consists of, what the variables are, identifying the problem, the objectives of their research, they clearly identify which is a dependent variable and which is an independent variable. [...] Also, the students have become familiar with the content and rules of the APA standards, [...] they also recognize the importance of attributing the corresponding authorship of the different articles, magazines. [...] However, despite having identified the importance of attributing authorship to different texts, they still have difficulties in citing correctly, especially when paraphrasing, when citing certain authors, they present certain drawbacks.

D6: I see that they have learned many aspects of the formal, as I told you, of a matrix, of variables, of sources, of APA format, things that perhaps we have seen in higher education, our boys have it as part of their language It's not that they master it, but at least they use it, they don't handle it fully, but it is also complex and they are just starting this aspect, but they already have a closeness to it and I think it is a very big advantage for their next university stage. Teachers agree that students have made progress in developing scientific thinking and research skills. Adequate management of basic concepts and tools such as the formulation of hypotheses, identification of variables, dependent and independent variables, matrices, sources and APA format is observed. Students also become familiar with APA standards and the importance of authorship, although they still have difficulty citing correctly, especially when paraphrasing.

It is important to highlight that this process is gradual and requires time and work from the earliest grades, respecting the level of development of each student. Collaboration between teachers, students and the educational community is essential to achieve significant improvement in these areas. High school students are developing a solid foundation in scientific thinking and research, which will give them a head start in college.

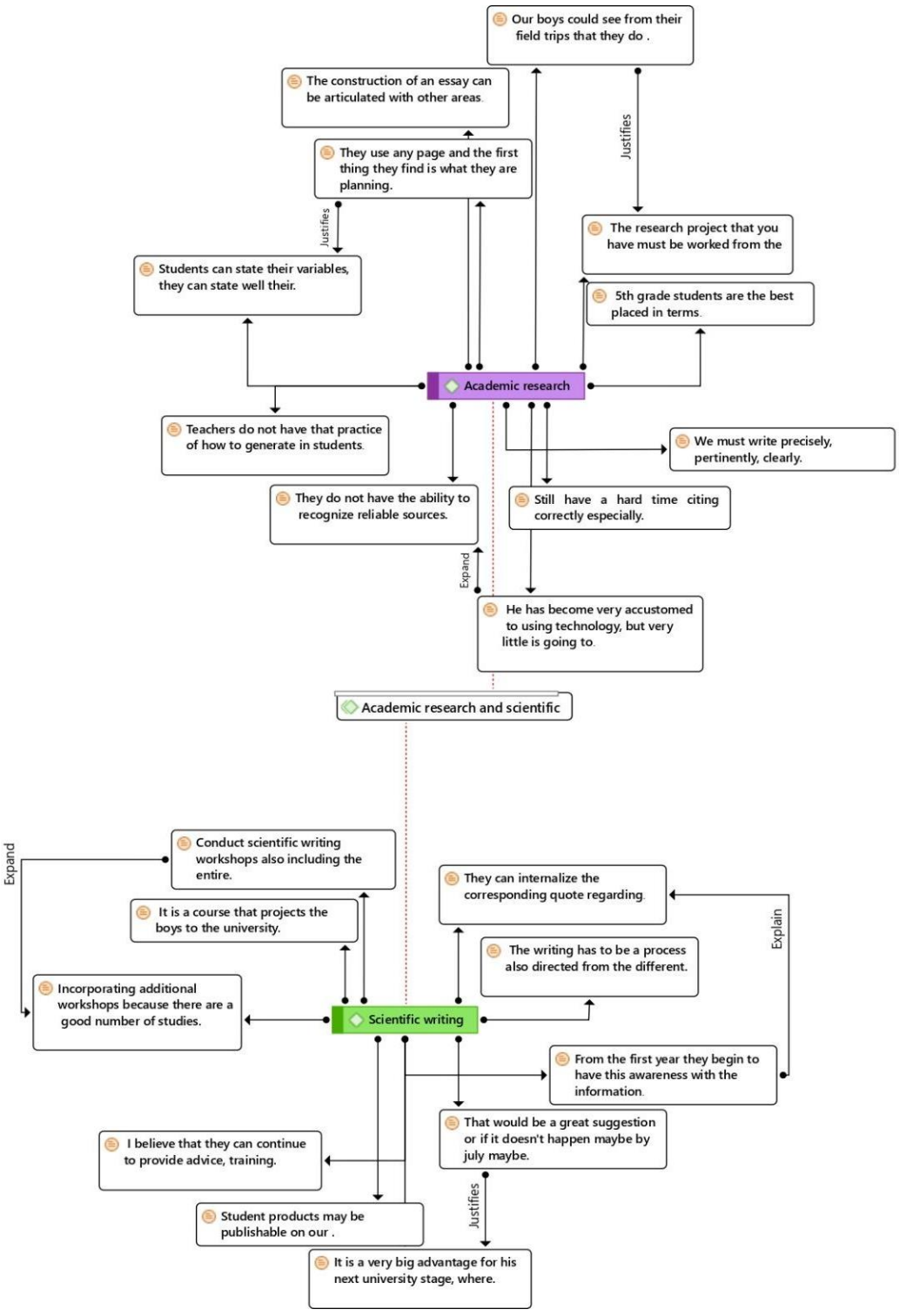


Figure 3. Academic and scientific writing

4.2. Analysis through the Maltese cross

The Maltese cross is formed by the cardinal points east, west, north and south. in the north part, the 9 confirmed and validated activities are located, as shown in Table 4), in the east and west part, the input and output information for each confirmed and validated activity is placed, and in the south, the information processing procedures are located. which can be manual or automated. Figure 4 shows four quadrants that are northeast, northwest, southwest and southeast; where it is analyzed by combining them by doing the respective crossing, leaving 6 elements to analyze.

Table 4. Confirmed and validated activities

Emerging issues	Activities	Confirmed and validated activities (AV)
D1: reading comprehension - Influence of technology. - Lack of articulated work with other areas. - Recognition of students' reading habits.	- Use of varied strategies by the teacher and parents to encourage reading. - Incorporate more readings into the course. - Articulate reading comprehension with other areas. - Encourage complementary reading activities. - Reinforce aspects of text analysis in class.	AV1. Use of varied strategies by the teacher and parents to encourage reading. AV2. Promote complementary reading activities. AV3. Reinforce aspects of text analysis in class.
D2: writing and argumentation, - Teaching preparation in scientific writing. - Writing with technological tools. - Disjointed curricular proposal.	- Train teachers in scientific writing and argumentation. - Supporting students in scientific writing. - Address students' interests in reading. - Emphasis on the editing and production process of the texts. - Development of argumentative writing at all levels of the curriculum in a transversal way.	AV4. Train teachers in scientific writing and argumentation. AV5. Accompaniment to students in scientific writing. AV6. Development of argumentative writing at all levels of the curriculum in a transversal way.
D3: academic and scientific writing - Investigative competence of teachers. - Understanding of the objective of scientific writing by students. - Connection with other areas. - Insufficient hours to work on scientific writing.	- Strengthen teacher training in scientific and academic writing. - Articulate academic and scientific writing with other areas. - Expand the course schedule. - Reinforcement activities for academic and scientific writing outside of classes. - Disseminate students' work in various activities.	AV7. Strengthen teacher training in scientific and academic writing. AV8. Articulate academic and scientific writing with other areas. AV9. Disseminate students' work in various activities.

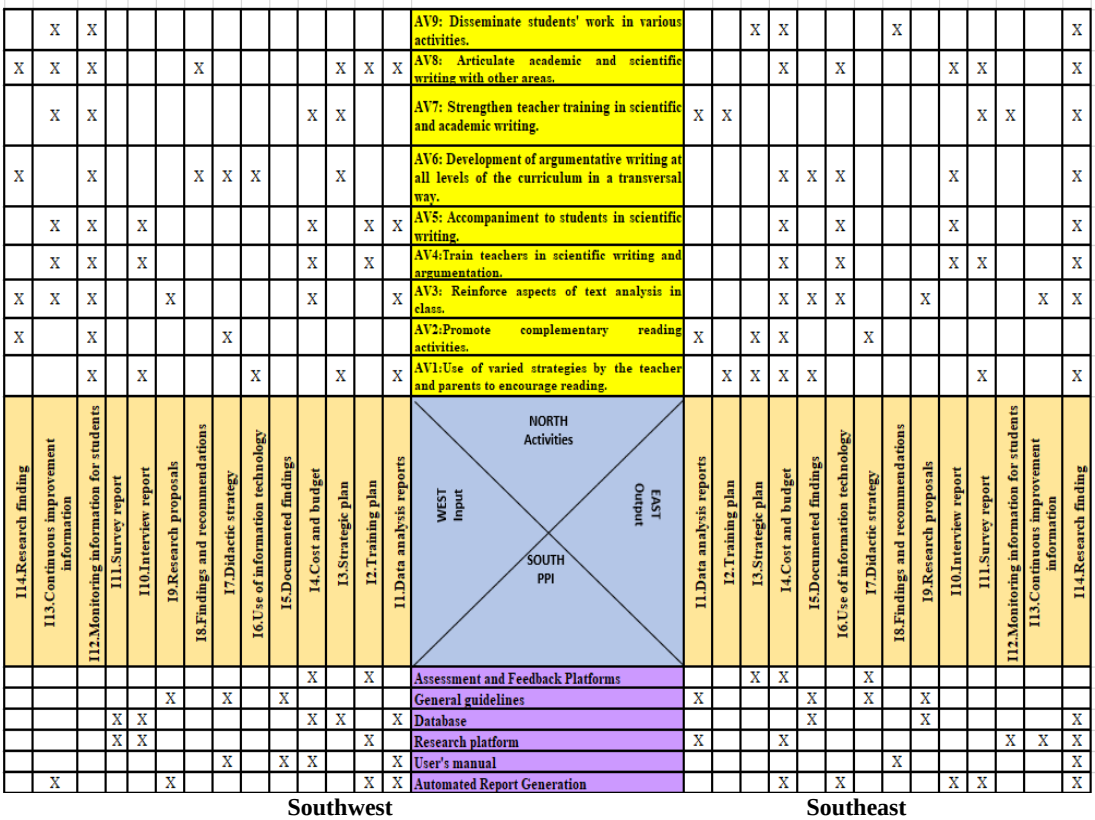


Figure 4. Maltese cross of validated and confirmed activities

4.2.1. Northeast vs. Northwest

The analysis of these pieces of information and activities reveals a combination of key aspects in educational management and continuous improvement in the academic realm. It highlights the importance of documented research findings (I14, I5), data analysis reports (I1), and research proposals (I9) as foundations for strategic decision-making. Furthermore, it emphasizes the development of crucial skills such as academic and scientific writing (AV8, AV7, AV6, AV5, AV4), text analysis in class (AV3), and the promotion of

complementary reading activities (AV2, AV1) to enhance comprehension and learning. These activities are supported by strategic (I3) and training (I2) plans, as well as continuous monitoring of information (I12) and dissemination of student work in various activities (AV9), demonstrating a comprehensive approach to strengthening educational quality and academic performance.

4.2.2. Southeast vs Southwest

The combination of the provided information, ranging from research findings (I14) to data analysis reports (I1) and research proposals (I9), along with information processing procedures such as assessment and feedback platforms, databases, and automated report generation, underscores the importance of efficient data management in educational and research settings. These elements are complemented by the need to use information technology (I6) and user manuals to optimize the implementation of didactic strategies (I7) and continuously improve educational and knowledge generation processes. This integrated approach reflects the synergy between data collection, analysis, and application in informed decision-making and continuous improvement in these contexts.

4.2.3. Northeast vs Southeast

The activities from AV9 to AV1 are combined in a relevant manner with the provided information, reflecting a comprehensive strategy to enhance educational quality. AV9, by disseminating students' work, aligns with the need to monitor information to assess student progress (I12) and disseminate research findings (I14, I5). AV8 aims to articulate academic writing with other areas, which is crucial for data analysis (I1) and the implementation of information technology (I6). AV7 strengthens teacher training in scientific writing, supporting the training plan (I2) and strategic plan (I3). AV6 develops argumentative writing, in line with findings and recommendations (I8) and reinforcement of text analysis in class (AV3). AV5 and AV4, by accompanying students and training teachers in scientific writing, respectively, directly link to research proposals (I9) and interview and survey reports (I10, I11). AV2 and AV1, in promoting complementary reading and varied strategies to encourage reading, rely on information monitoring (I12, I13) to continuously adapt and improve teaching strategies. This strategic combination spans from developing key skills to continuous improvement in the educational process, demonstrating a holistic approach to elevate academic and pedagogical standards.

4.2.4. Northwest vs Southwest

The combined analysis reveals the critical role of assessment and feedback platforms, general guidelines, databases, research platforms, and user manuals in efficiently managing and analyzing research findings, student data, and proposals. These components support validated activities such as disseminating student work, strengthening teacher training in scientific writing, developing argumentative skills, providing support in scientific writing, analyzing texts in class, and promoting reading activities. Detailed user manuals ensure effective implementation of these tools, directly contributing to enhancing educational quality and academic performance overall.

4.2.5. Northeast vs Southwest

One of the relevant elements to consider is AV7: Strengthen teacher training in scientific and academic writing, in combination with assessment and feedback platforms. This activity involves enhancing teachers' training in scientific and academic writing, which can be achieved by using assessment and feedback platforms. These platforms provide tools to assess the quality of teachers' writing and offer personalized feedback to improve their skills in this aspect. Additionally, the use of general guidelines and user's manual can provide clear guidelines and detailed guidance on how to effectively use these platforms in the teacher training process. Together, these tools and activities significantly contribute to improving the quality of teachers' academic and scientific writing, which has a direct impact on the quality of education received by students.

4.2.6. Northwest vs Southeast

The activities along with assessment and feedback platforms, general guidelines, database, and research platform creates a conducive environment for enhancing educational quality and academic performance. Assessment and feedback platforms facilitate the assessment of student progress in areas such as academic and scientific writing (AV8, AV9, AV6, AV5) and enable specific feedback to improve these skills. The general guidelines provide clear guidelines for implementing effective strategies, such as promoting complementary reading (AV2) and using varied approaches to reading (AV1). The database and research platform support research and data analysis (I1, I14, I9), essential for developing strong arguments (AV6) and strengthening teacher training in scientific and academic writing (AV7, AV4). Together, these elements promote a culture of continuous improvement in learning, providing essential tools and guidance for academic growth and the development of critical skills in students.

4.3. Survey analysis

4.3.1. Analysis by dimensions of the fourth year of secondary education

According to the data, 1.63% of the students are in the low achievement category in reading comprehension. This implies that a very low percentage of students present a deficient level of ability in this area. While 34.96% of the students are in the category of fair performance in reading comprehension. This indicates that a significant proportion of students are at an average level of ability in this area, suggesting that they can comprehend texts to an acceptable degree, although they may need to improve certain aspects of their skills. Likewise, 63.41% of the students are in the high-performance category in reading comprehension. This percentage is quite high and shows that most of the students have achieved an advanced level of reading comprehension ability. These students can comprehend texts effectively and extract relevant information from them. On the other hand, 37.80% of the students are in the regular performance category in writing and argumentation. This indicates that a significant proportion of students are at an average level of ability in this area. Although these students can write and argue to some extent, they may need to improve some aspects of their ability to communicate effectively in writing. In addition, 60.63% of the students are in the high-performing category in writing and argumentation. This percentage is quite high and shows that most students have achieved an advanced level of proficiency in these areas. These students can write texts in a coherent, structured and persuasive manner, and can construct solid and convincing arguments.

According to the data, 2.36% of the students are in the category of low performance in academic research and scientific writing. This implies that a very low percentage of students have developed poor skills in these areas. However, these students may face difficulties in conducting adequate scientific research and writing accurately and coherently in a scientific style. Also, 51.97% of the students are in the category of fair performance in scientific research and scientific writing. This indicates that a significant proportion of students are at an average level of ability in these areas. These students can perform basic scientific research and scientific writing with some proficiency, although they may need to improve some specific aspects of their skills. In addition, 45.67% of the students are in the high achievement category in scientific research and scientific writing. This percentage is relatively high and shows that a considerable portion of the students have achieved an advanced level of proficiency in these areas. These students can conduct rigorous scientific research, apply appropriate methods and techniques, and write scientific texts in a clear and precise manner.

4.3.2. Analysis by dimensions of the fifth year of secondary education

Statistical data show that 0.72% of students are at a low level of reading comprehension. These students present considerable difficulties in comprehending texts, such as extracting relevant information, making inferences, and understanding the structure and purpose of the text. As for the regular level of reading comprehension, 50% of the students fall into this category. These students have acceptable skills to comprehend texts in general, although they may face difficulties with more complex texts or with more abstract information. Although they are at an average level, there is still room for improvement in their reading comprehension skills. On the other hand, 49.28% of the students demonstrate a high level of reading comprehension. These students possess advanced skills to comprehend texts of different levels of complexity. Likewise, they are capable of deep analysis, sophisticated inferences and relating information effectively. 33.33% of the students are at a regular level of writing and argumentation. This implies that they possess acceptable skills in written expression, but may face difficulties in the structuring of ideas, coherence and cohesion of the text, as well as ineffective argumentation. On the other hand, 66.67% of the students demonstrate a high level in writing and argumentation. These students present advanced skills in written expression, being able to structure their ideas clearly and coherently, present solid and well-founded arguments, and develop persuasive reasoning. The majority of students are at a high level of writing and argumentation, which indicates that they possess developed skills in written expression and the ability to argue effectively. However, there is still a significant percentage of students who are at an average level, suggesting the need to improve their ability to structure texts, maintain coherence and elaborate more solid arguments.

On the other hand, 1.45% of the students are at a low level of academic research and scientific writing. These students present significant difficulties in conducting academic research and writing scientific texts adequately. This may indicate a lack of skills in gathering and analyzing information, as well as in the rigorous and accurate presentation of results. Regarding the regular level of academic research and scientific writing, it is observed that 44.20% of the students fall into this category. These students have acceptable skills in the development of research and the writing of scientific texts, although they may present limitations in terms of depth of analysis, use of adequate sources and structuring of the work. On the other hand, 54.35% of the students show a high level in academic research and scientific writing. These students demonstrate advanced skills in conducting research and writing scientific texts.

4.3.3. Proposed model

The proposed innovative model for formative research in secondary education at this school consists of three distinct stages, each building upon the previous one. In the first stage, during the first year, students focus on comprehension reading 1, and in the second year, they progress to comprehension reading 2. This progressive approach ensures that students develop strong foundational reading skills before moving on to more complex tasks. The second stage, which spans the third year, is dedicated to developing writing skills. In the first semester, students engage in writing, and in the second semester, they advance to argumentation. This sequential structure ensures that students can effectively express their thoughts and ideas through writing, which is a crucial skill for academic success. Finally, in the third stage, spanning the fourth and fifth years, students embark on a journey of academic research in the fourth year, followed by scientific writing in the fifth year. This sequence prepares them for advanced academic work and empowers them to conduct research effectively and communicate their findings in a scholarly manner. This model fosters a gradual and comprehensive approach to research skills development, ensuring that students build a strong foundation in reading, writing, and research throughout their secondary education. It emphasizes the importance of progressively challenging students to achieve higher levels of academic proficiency, making them well-prepared for future academic and professional endeavors, as shown in Figure 5.

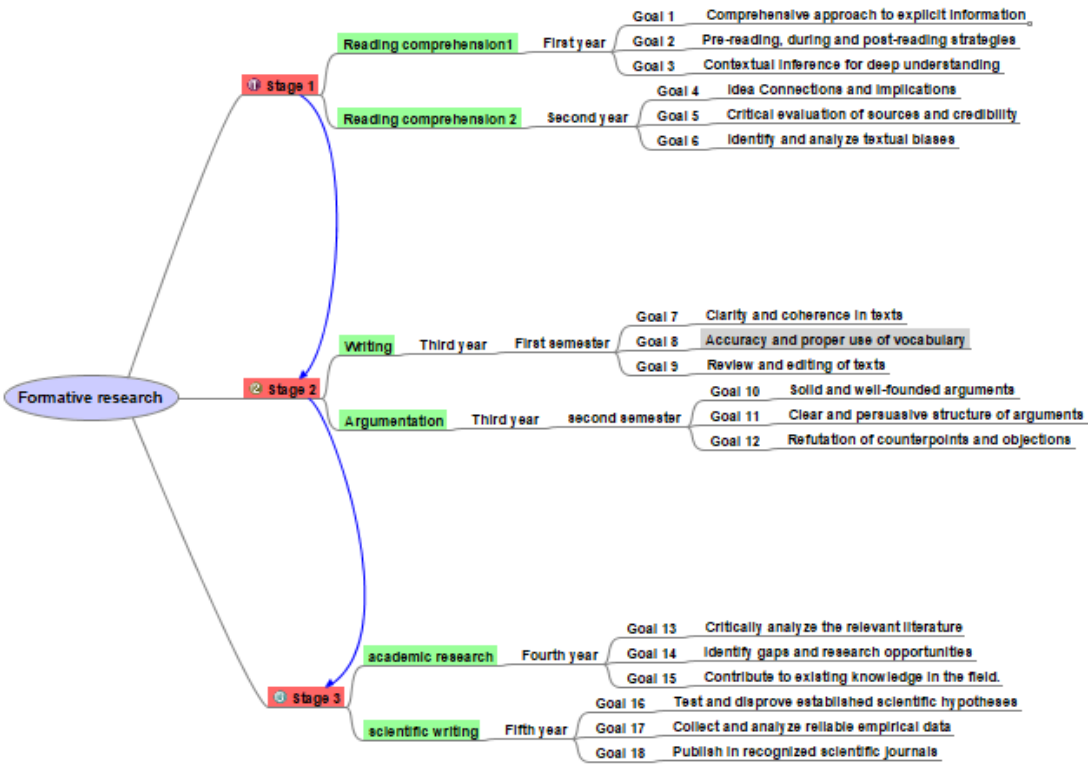
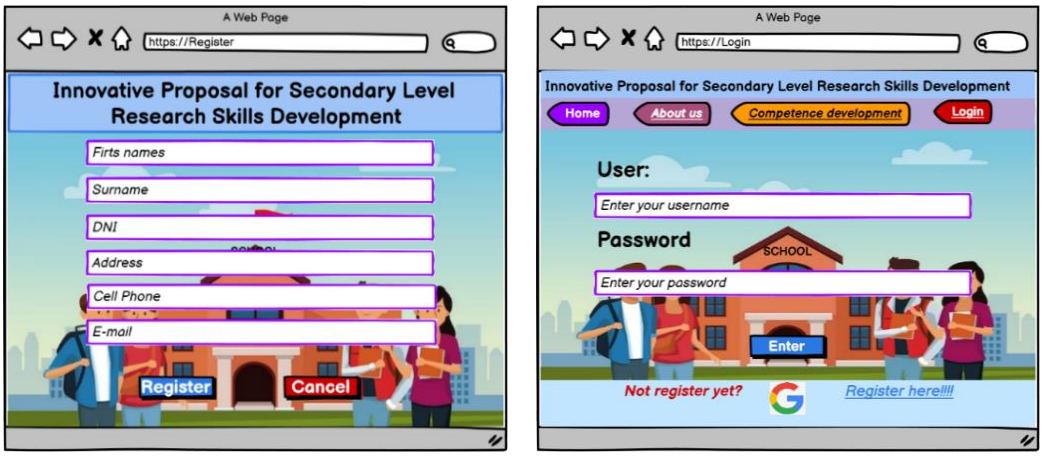


Figure 5. Formative research model

Prototypes were then designed according to the formative research model, featuring different interfaces focused on specific skills for different grade levels. The prototypes include screens designed to help students develop critical skills through interactive and well-structured exercises. Each interface is user-friendly and accessible, with an intuitive design and accessibility features such as text-to-speech and high-contrast options. In addition, they offer personalized learning paths that adapt to student performance and progress, as well as progress monitoring through graphs and statistics. Students also receive immediate feedback on their answers and have access to additional resources such as supplemental study materials and educational videos, facilitating a personalized and continuous learning experience.

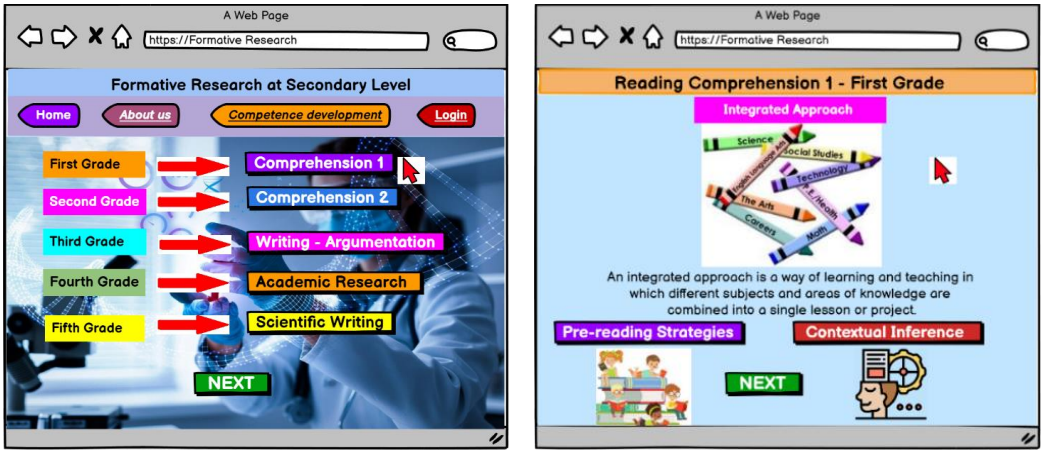
Figure 6 shows the registration and login process in an application. Let's break down each of the parts of the figure for a detailed explanation. Figure 6(a) shows the user interface corresponding to application registration. Here are the fields required for a new user to create an account. Typical fields that are included in a registration form. Likewise, Figure 6(b) shows the user interface corresponding to logging into the application. Here are the fields required for an existing user to access their account.



(a) (b)

Figure 6. Formative research (a) registration and (b) login

Figure 7 presents two screens of the educational application, each of which focuses on different aspects of student education. Figure 7(a) shows the welcome screen of the educational application. This interface is designed to welcome users and provide an initial introduction to the application. Figure 7(b) shows the reading comprehension screen for first grade, with a reading text, comprehension questions, spaces for answers, clear instructions, recognizing the main topic and also the use of contextual inference in the text.



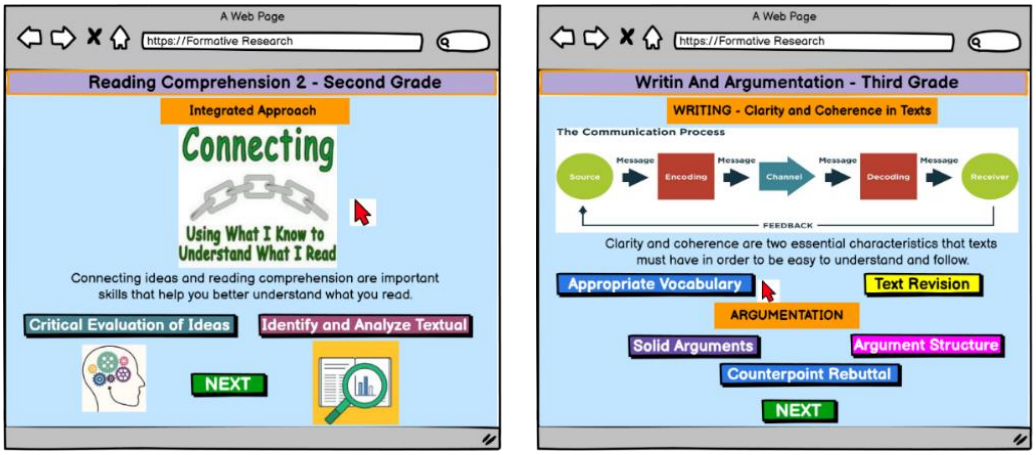
(a) (b)

Figure 7. Formative research (a) welcome and (b) reading comprehension –1° grade

Figure 8 shows two screens of the educational application, each focused on different skills and grade levels. The first screen focuses on reading comprehension for second grade, and the second on writing and argumentation for third grade. In Figure 8(a) shows a screen dedicated to reading comprehension exercises for second grade students. This interface is designed to help students improve their ability to comprehend more complex texts compared to first grade. Typical elements on this screen include xomo reading text, comprehension questions, assessments. Figure 8(b) shows the writing and argumentation screen for third grade, with a writing prompt, a writing space, a submit button, instructions, and specific objectives (goals) that include developing a clear and coherent argument supported by evidence and using correct grammar and spelling in writing.

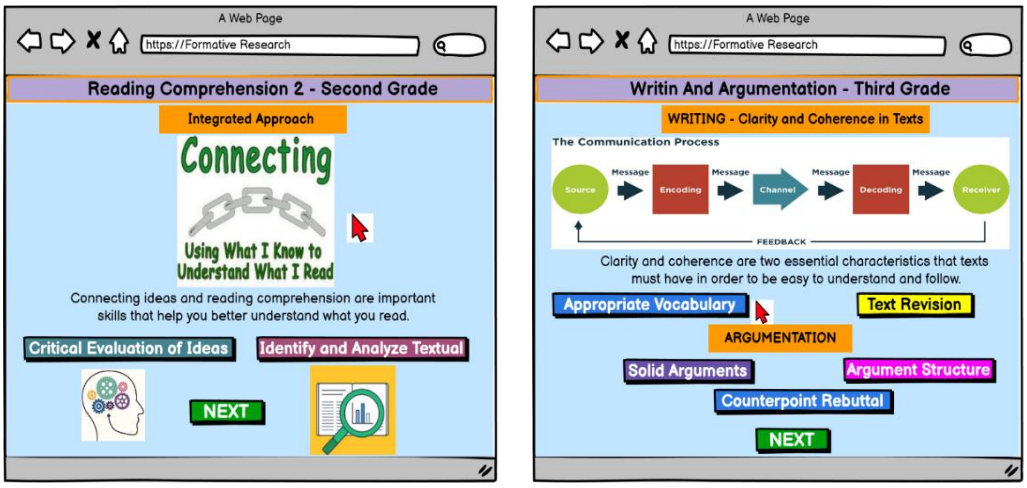
Figure 9 presents two screens of the educational application, each focused on different skills and grade levels. The first screen focuses on academic research for fourth grade, and the second on scientific writing for fifth grade. Figure 9 (a) shows a screen dedicated to academic research exercises for fourth grade students. This interface is designed to teach students basic research skills and how to present their findings.

Typical elements in this screen include as a research topic, research instructions. Similarly in Figure 9 (b) a screen dedicated to science writing exercises for fifth grade students is shown. This interface is designed to teach students how to structure and write scientific papers. Typical elements in this screen include writing instructions, scientific writing steps.



(a) (b)

Figure 8. Formative research (a) reading comprehension – 2° grade and (b) writing and argumentation – 3° grade



(a) (b)

Figure 9. Formative research (a) academic research – 4° grade and (b) scientific writing – 5° grade

5. DISCUSSION

Students recognize more how to write a scientific text, they recognize that it is necessary to change a title, refer authors, make a summary, develop the body of the scientific text, reach conclusions and also point out the bibliography and especially when it is a scientific text or article, they analyze more the bibliographic references, the concepts proposed by the authors and give a critical appraisal. There are limitations about the development of research skills related to the reading habit, which starts even from the teachers themselves. The analysis should start from knowing how we are in the reading habits, processes of analysis of a reading, as well as knowing how to find the central ideas, the techniques; that should be formed from the first grades of primary school, and thus have a basis in secondary school; however, the author Sabirova and Zakirova [11] states differently that research courses should be extracurricular. These skills should be raised as a requirement in all class sessions, curricularly it should also be transversal to the areas from all grades associated with the area of mathematics, in which they locate the essential data for problem solving.

For a student to be able to write optimally, multiple skills must be reinforced, not only in a specific area but in several areas that can contribute to the achievement of the objective. To this end, a plan is being made to train teachers first. While it is true that in the quantitative study it comes out as an acceptable average, but in the qualitative it shows some difficulties; similar to the research conducted by Harja and Sinaga [13] and Sunyono [14] where scientific skills are low. Students have conditions for the process of critical thinking, to have a practice of democratic coexistence, a form of dialogue with students, teachers, classroom assemblies, where they generate conditions for them to have the possibility of more argumentation, more discussion, but what is happening is that there are still some situations to be strengthened from the various areas, a greater degree of this impulse to strengthen it. Sometimes argumentation is thought and left only to the area of communication or suddenly also to some contests selecting students to go to debate and it does not become a fundamental element, even in our own educational proposal where the student is an autonomous person, who manages critical thinking, but sometimes it is not fully observed in practice as argumentative spaces; agreeing with the author Zer-Kavod [17] where he states that students have difficulties in writing with argumentation correctly. What is lacking is to have a teaching staff that has the profile of a research teacher; in this way, they can radiate their knowledge to their students from the first years of study. In addition, teachers should have a holistic view so that they can develop it transversally in the different courses; agreeing with the author Huaman [9] he states that it is important to study different disciplines, i.e. interdisciplinary, to achieve the objective systemically.

In that sense, it should be more and more a unit within the work so that it can be enhanced; where periodically there should be meetings with teachers who teach courses related to reading comprehension, writing and argumentation and academic and scientific research so that together they achieve the goal set by the institution. For this, there should be much more organic work where the authorities should place within its curriculum a new educational proposal that allows developing research skills of high school students. That is why the educational proposal was made through an innovative educational model for secondary education, to be implemented from 2024 onwards.

6. CONCLUSION

In the quantitative analysis, the research skills of the students under study about reading comprehension, writing, argumentation, and academic and scientific writing are within the average. However, upon conducting a more detailed qualitative analysis, it was observed that some students presented specific difficulties in scientific writing, while they showed a remarkable strength in reading comprehension from a critical perspective. Through this qualitative approach, it was discovered that some students presented specific difficulties in scientific writing. These difficulties could include problems in properly structuring a scientific report, using precise and clear language, or effectively presenting research results. On the other hand, the Maltese cross allowed for an in-depth analysis by quadrants in terms of the confirmed and validated activities and the emerging problems identified. In addition, the prototypes were based on the mind map, allowing to establish adequate designs for the innovative model proposal. One limitation was that the Ministry of Education proposes a mandatory national curriculum design with 70% of what all schools must do in secondary education. However, the remaining percentage was used to carry out the research proposal in secondary education. It is suggested as future work to scale up the research to propose an innovative model of research skills in secondary education in Peru. In addition, this model should be implemented in the school under study starting in 2024.

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