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Exploring Gender Differences in Science Critical Thinking Skills

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Critical thinking thrives in a culture of diversity and gender parity,
where every voice, regardless of origin,
is heard and respected.

Abstract

This study investigates the development of critical thinking skills in science education, as well as the influence of gender roles on these abilities. In today's hyperconnected world, kids must be able to distinguish reliable information and think critically. Critical thinking in science entails observation, research, and problem solving. However, developing these abilities is difficult, especially when dealing with gender inequality. This qualitative study was conducted at Sant Martí school in Cerdanyola del Vallès with 25 sixth-grade kids. Students took an initial critical thinking test and participates in a debate, with observations focused on their argumentation methods and interactions. The findings emphasize gender disparities in critical thinking and the importance to abolish them for a more successful education. Moreover, these findings seek to assist educators and policymakers establish inclusive scientific education programs that enhance critical thinking for all students.

Key words: critical thinking, gender roles, science education and primary school.

Resum

Aquest estudi investiga el desenvolupament d'habilitats de pensament crític en l'educació científica, així com la influència dels rols de gènere en aquestes habilitats. En el món hiperconnectat d'avui, els infants han de ser capaços i capaces de distingir informació fiable i pensar críticament. El pensament crític en ciència implica l'observació, la recerca i la resolució de problemes. No obstant això, desenvolupar aquestes habilitats és difícil, especialment quan es tracta de la desigualtat de gènere. Aquest estudi qualitatiu es va realitzar a l'escola Sant Martí de Cerdanyola del Vallès amb 25 infants de sisè de primària. Els estudiants van fer una primera prova de pensament crític i van participar en un debat, amb observacions centrades en els seus mètodes d'argumentació i interaccions. Les troballes posen l'accent en les disparitats de gènere en el pensament crític i la importància d'abolir-les per a una educació més reeixida. A més, aquestes troballes busquen ajudar els educadors i educadores i els i les responsables polítics a establir programes d'educació científica inclusiva que millorin el pensament crític per a tots els i les estudiants.

Paraules clau: pensament crític, rols de gènere, educació científica i educació primaria.

Resumen

Este estudio investiga el desarrollo de las habilidades del pensamiento crítico en la educación científica, así como la influencia de los roles de género en estas habilidades. En el mundo hiperconectado de hoy, los alumnos y alumnas deben ser capaces de distinguir información fiable y pensar críticamente. El pensamiento crítico en la ciencia implica observación, investigación y resolución de problemas. Sin embargo, es difícil desarrollar estas capacidades, especialmente cuando se trata de la desigualdad de género. Este estudio cualitativo se llevó a cabo en la escuela de Sant Martí en Cerdanyola del Vallès con 25 niños de sexto de primaria. Los estudiantes realizaron una prueba de pensamiento crítico inicial y participaron en un debate, con observaciones centradas en sus métodos de argumentación e interacciones. Los hallazgos ponen

en relieve las disparidades de género en el pensamiento crítico y la importancia de eliminarlas para una educación más exitosa. Además, estos hallazgos buscan ayudar a los educadores y los responsables políticos a establecer programas de educación científica inclusivos que fomenten el pensamiento crítico para todos los estudiantes.

Palabras clave: pensamiento crítico, roles de género, educación científica y educación primaria.

Greetings

I would like to express my deepest gratitude:

To my tutor Carme Grimalt, for her help, patience and willingness during the creation process. His knowledge and experience on the subject has been very motivating to carry out this research. Thank you for trusting me from the beginning and not to stop doing so during the process. Thank you very much.

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However, this goes for my parents, Jose and Rosi, who have always believed in me more than I do. Because being brave is easier when I know you're at my side. I'd want to thank you from the bottom of my heart for being my greatest inspiration throughout this thesis.

I hope you feel as fortunate to be my parents as I am to be your daughter.

For my guardian angels, I'd love to be enjoying this with you. Although I know you're already helping me wherever you are. I love you.

“Nothing is impossible. Hard many things are”

-Yoda-

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1. Introduction

Nowadays, fostering a scientifically educated society, in the constantly evolving educational context, demands an understanding of the multiple variables influencing students' capacity for critical thinking. The development of critical thinking is at the basis of the formation of citizens capable of facing very diverse social situations freely, rationally and democratically (Lipman, 2016). Therefore, scientific education should be able to not just promote the development of these capacities but that is done in an adequate level.

Currently, we live in a hyperconnected world where there are a lot of information arising. For that reason, there is a big necessity to help students develop critical thinking skills to distinguish opinions or detect biased or false information.

On the other hand, if we focus on critical thinking linked to science education we can see how present and relevant is. Critical thinking is generally present in processes that are associated with scientific procedures or research, such as observation, investigation, and others (Demir, S., 2015), as well as in the creation of accurate data (Osborne, J., 2014). Additionally, activities including problem solving, investigation, research, critical thinking, and identifying problems are particularly involved in science applications (Gomes, 2005; quoted in Demir, 2015).

Demi (2015), states in one article that "Teachers who can think creatively and critically based on a scientific perspective, and who can see events from different angles occupy an important place in education. Training science teachers who have creative and critical thinking, as well as a scientific perspective, is particularly important for raising future generations…". This quote reflects the importance of critical thinking in science education, and in education in general. However, it is crucial to note that there is limited guidance on how to foster critical thinking as a teacher, particularly how to address inequities in scientific education while encouraging critical thinking.

Besides, one of the variables that can affect the development of such capacities might be the students' gender roles. Gender is a broad term that refers to men and women (Fin & Ishak, 2012), and it shapes psychology and social roles (Fuad et al., 2012), influencing how people think, behave, and feel about themselves (Santrock, 2011). In other words, gender refers to traits and actions that are appropriate for men and women based on cultural assumptions. All these cultural preconceptions are seen in the classroom, since boys tend to be more active, ask questions, and be more aggressive in verbal activities than women (Altermatt et al., 1998; Brophy, 2004).

There is an extensive understanding about the idea that equity and quality are two top priorities in an educational system. As a result, the goals of the policies created by the educational administrations are to attain high-quality instruction and the best possible outcomes. In other words, that the students acquire the knowledge, skills, attitudes and values that enable them to successfully incorporate into the social and professional world as competent citizens. But, at the same time, there is a concern to achieve the equity in the students' learning process facing the inequalities. However, one of the variables that can affect the development of such capacities might be the students' gender roles What is more, in some occasions, the gender roles that identify each student and have an impact on kids' academic performance provide a significant barrier to the realization of this equity.

2. Objectives

The purpose of this small-scale study is to illustrate the complex relationship that exists between students' gender roles and their scientific critical thinking. My aim is to shed light on any patterns or discrepancies that could exist among the students' gender roles by looking at the influence of gender stereotypes, enrolment in the classroom, relationships between the pupils, and other relevant conditions. Comprehending these processes is essential for educators and policymakers who want to develop inclusive and successful scientific education initiatives.

The general objective is:

1. Analyze the relationship between students' gender roles inside the science class and their critical thinking skills while interacting with their peers.

The specific objectives are:

1. Assess 6th grade students' initial critical thinking skills before participating in a science activity.
2. Characterize students' critical thinking skills when they interact with their peers in a whole-group science debate.

3. Theoretical framework

Critical thinking

Critical thinking is a process of thinking, so a cognitive process which can not be easily observed with our own eyes while is happening. However, what we can see and analyse are the products of this process when it takes place.

According to Facione, critical thinking is the deliberate, self-controllable judgment of information and arguments through interpretation, analysis, evaluation, and reasoning. It necessitates thoughtful and metacognitive processes in addition to simple problem solving. Additionally, the ideal critical thinker is seen as someone who is inquisitive in nature, open-minded, flexible, fair-minded, has a desire to be well-informed, understands diverse viewpoints, and is willing to both suspend judgment and to consider other perspectives (Facione, 1990) Furthermore, he highlights the necessity of clearly teaching and evaluating critical thinking abilities in educational programs in order to get pupils ready for the challenges of addressing problems in the real world.

On the other hand, Richard W. Paul and Jane Wilson emphasize in their work the importance of fair and objective assessment that goes beyond rote memorization and superficial understanding. They emphasizes the cultivation of fairminded critical thinkers who are able to analyze, evaluate, and apply intellectual standards to their thinking. The assessment methods should reflect this emphasis on the development of essential intellectual traits and adherence to critical thinking standards.

Critical thinking in science

Hagop A. Yacoubian (2015) claims that there are several reasons why teaching science in schools should include the study of nature and science as a component of critical thinking. These include, but are not limited to, humanizing the sciences and placing them in ethical, political, cultural, and personal settings; helping to create the ideal democratic society; and encouraging a deeper comprehension of the scientific material.

This article bySutiani et al. (2021) “Implementation of an Inquiry Learning Model with Science Literacy to Improve Student Critical Thinking Skills” offers an inquiry-based approach paradigm for fostering critical thinking in scientific education. Inquiry-based approaches in education refer to teaching and learning methods that prioritize active exploration, investigation, and problem-solving. These approaches encourage students to pose questions, seek answers, and construct their own understanding of concepts. The goal is to foster curiosity, critical thinking, and a deep engagement with the subject matter.

Critical thinking in debates

The capacity to explain ideas clearly and eloquently is acknowledged as a critical component of success in any discipline. Effective communication is essential while navigating academic efforts, entering the professional field, or contributing to social conversation. The art of debate is crucial to developing this important skill set.

The basic idea behind employing debate in education is to give pupils an organized forum for engaging in intellectual exchange. This is consistent with the greater purposes of education, which

are to cultivate critical thinking skills as well as to teach information. According to research (Brown & Smith, 2019), students who participate in frequent debating activities increase their skills in analysis, reasoning, and knowledge synthesis.

Patel et al. (2021) conducted a longitudinal research that supports the favorable impact of discussion on critical thinking. Their research observed students who took part in debate programs throughout their time in school, finding a consistent improvement in their capacity to think critically and make informed choices. The organized framework of debates encouraged students to deconstruct arguments, identify logical fallacies, and reach evidence-based conclusions.

Furthermore, this article («Using the Power of Debate to Enhance Critical Thinking», 2023) investigates how debates provide a forum for students to discuss sensitive matters, express their thoughts, question opposing viewpoints, and defend their positions. Debates allow students to question problems, examine evidence, and develop logical arguments, which improves their critical thinking and logical reasoning abilities.

The influence of gender in the use of language

Each student has a unique learning experience. It should be mentioned that simply teaching students how to think critically may not be enough. Aside from critical thinking, there are additional aspects that might influence its quality. Gender is one of these variables. It is an underappreciated component that affects many parts of life, including reading, talking, and thinking (Douvan, 1975). Male and female pupils get different learning results. Properly, men and women have different cognitive processes (Izzati et al., 2019).

A few studies indicate a strong link between critical thinking (CT) abilities and gender. On the one hand, Walsh's (1996) research found that females had better levels of CT abilities than males. On the other hand, research by King, Mines, and Wood (1990) found that the CT scores of graduate students varied by gender. In their investigation, guys performed better than females.

In a study by Aukrust (2008), boys' dominance in classroom discourse is demonstrated through quantitative research that investigates the amount of time that boys spend talking in contrast to girls, as well as the various sorts of contributions that girls and boys make to classroom dialogues. This is an intriguing aspect to highlight, as females are regarded as having better language abilities in both academic testing contexts (ACARA 2018; OECD 2019a) and social situations (Eckert 2000). Similarly, Blair (2000) discovers that there is a strong masculine dominance in public discourse through her research with eighth-grade pupils.

Furthermore, Collins and Johnston-Wilder (2005) notice that a disproportionate percentage of females, compared to boys, have spent entire days in school not participating in the types of conversations that their teachers see as essential to learning. These quantitative analyses show that boys dominate classroom discussions.

According to Leaper (1994), this is related to the behavioral norms required of children in gender-segregated peer groups. She claims that gender-typed activities for females encourage nurturing, affection, and social sensitivity, whereas boys' activities emphasize aggressiveness, competitiveness, and dominance. This can be attributed to females' caring and thoughtful

temperament and boys' competitive and domineering disposition in other areas, such as classroom discussions (Goodwin and Kyratzis 2014, p. 511).

4. Methodology

This small-scale study will follow the qualitative scientific method. The reason why it follows this method is because when facing critical thinking it gives to the research some benefits. Some of the benefits are such as the opportunity to have a more depth and contextualised exploration about it letting capture more details and individual perspectives. Moreover, since this method has the particularity of having an inductive method, the conclusions can be created at the end when the date is recollected.

4.1. Context and participants

This study will be done in Sant Martí school, placed in Cerdanyola del Vallès. It is a one line centric school considered as a high complexity centre. In it we can find a huge diversity of nationalities. However, muslim families are the most predominant in the centre.

Otherwise, the socioeconomic background of the families of this is school is quite homogeneous, low socioeconomic background.

The participants of this study will be the 6th grade class, formed by 25 students. In it, we can find 14 girls and 11 boys. It can be observed that most of the students come from migrant families. All the students will be participants, so all of them will be the sample for the recollection of data and the creation of conclusions. The selection of this sample relies on the possibility of having a large sample in order to make comparisons among students regarding gender.

4.2. Design of the activity[1]

Part of the actual study was carried through the recollection of the students production to an initial test in the science class. This intervention aims to put into practice their critical thinking skills through some exercises. At first, they are given a test where they will show how do they apply their critical thinking and which are their most reliable information sources. They will be given several sources and they will rate them from 1 to 3, one being the less reliable source and three the most reliable one. Finally they will draw a figure following the numbers they provide to each of the argumentation sources.

Further to this, the students will be asked to work on some news and by following a guide, provided by me, investigate if it is real or fake. Afterwards, each group will present their new and explain why it was real or fake following a checklist given as a support measure. For this process none of the students will be given any indication of which might be the roles distribution among them while presenting their new. They will have to decide which is the role of each of the integrants of the team in this task. This fact will be observed while they are presenting.

After those presentations all the class will have an overall reflection about what we have learned. To, finally, do a debate of the topic presented in the initial test (Pyrotechnic). Before carrying out the debate the students will be given time to look at references for the construction of their arguments for the debate. For the purpose of debate, my tutor in this internship and I will be using a grid, which we filled up during the argument. In this grid we note down different items such as the times each of the pupils participate as well as the time they spend talking, and other items that you

[1] To see the material used go to the annexes.

can look up in the Annexes. After the debate we both dumped our information into the same excel grid. This debate is aimed to be done in one hour session, but it will depend on the unforeseen events that may happen in the class.

These material was created taking into account the MOPC (*Mapa operatiu del pensamiento critic*) and based on the EDAPC[2] (*Esquema de diseny d'activitats de pensament critic*) which is a table where there are the requirements that a critical thinking activity needs to have. Those resources were found in a research made by Vila Tura, L., Márquez Bargalló, C., & Oliveras Prat, B. (2022). *Una propuesta para el diseño de actividades que desarrollen el pensamiento crítico en el aula de ciencias.*

4.3. Ethical considerations

Students were not identified during the data collection process, so observations were done anonymously. Also, no filming or recording was made. Furthermore, regardless of identity, the focus of this study is on their responses and development within the classroom. As a result, the observations and analysis were done in a general manner without mentioning any of the students' names or unique personal traits.

4.4. Instruments for data collection

Two different data collection methods were employed in order to address the research question. In advanced to the different activities the students will be given an **initial test**[3] where they will reflect, in a small scale, how do they apply their critical thinking in science in addition to their most reliable information sources. This test is structured with three different questions about an instagram post that opens the reflection of being in favour with pyrotechnics or not. Also, some comments that the followers wrote to that post. Those answers express the opinion of each of the followers, however, each comment is based on a different source of information.

The sources presented in that test were influenced by an article called " are the explanation as an argument, which relies on the defense of how the fact occurred. Moreover, the use of data—using numerical data, statistics, and graphs about the topic—to reinforce the argument. Also, the use of reason refers to use one's own reasoning to elaborate a fact. Furthermore, habits are another source of information, and it implies customs and traditions that have become usual. Additionally, experiences refer to vivid events. Finally, authority is the last source of information when giving an argument, which refers to citing someone of importance (person, university, or institution) who makes this claim.

Finally, this data collection strategy allows me to recall the students' productions in order to determine their starting point for the various information sources before proceeding with the other activities, as well as their criteria in front of the various argument sources paying attention to the differences between boys and girls.

[2] You can see the schemes in annex 3

[3] You can see the activity in annexes 1.

On the other hand, an **observation grid**[4] will be used to analyse the students while they are doing the debate, this fact will let me observe how do they relate with each other with a gender perspective.

This observation grid consists of several items viewed in an article called "*Una propuesta para el diseño de actividades que desarrollen el pensamiento crítico en el aula de ciencias*" by Vila Taura et al. (2023).

On one hand, the different sources of argumentation that appeared in the initial test. These sources will be observed in each of the interventions that the students make to finally make a recount of the most used sources having also a gender perspective. In the grid this part adopt the name of "*Quality of evidences*".

On the other hand, other items that are taken into account in each of the students' interventions are the "*Types of interventions*". This section details how students communicate with each other throughout the debate and it will . If the student uses questions, affirmations, denials, rebates the other players, or just accepts what the opposition side asserts.

At the end, this recollection of data will allow me to create correlations between the types of interventions performed by each gender and see whether there is a pattern or not.

4.5 Instruments for analysis

I evaluated the various sources of information and the quality of the students' evidences, then converted this information into numbers and used descriptive statistical methods to identify patterns. This is a very common analytical approach in qualitative research.

The analysis will focus on how students argument when they are not socializing with the initial test. This test will allow me to determine their preferences without relying on social interaction influence. On the other side, I will analyze what happens when students socialise. To be able to do so, the observation grid allowed me to examine what happens when gender roles interact on the social level. In other words, this evidence demonstrates how gender roles and critical thinking interact, which will be the final analysis of the research.

[4] You can see the activity in annexes 2.

5. Results

This section outlines the results extracted from the different collection methods used in this research. The appendices contain all of the material that was used, in this case the students' answers of the initial test and the grid of observation during the debate.

Students' answers of the initial test

All the students from the 6th grade class answered the initial test. The class consisted of 25 students in all; 14 of them were girls and 11 boys.

The exercise consists of numbering from 1 to 3, with one being the less trusted source and three being the one they trust the most, the different sources when giving an argument. The results will be captured by comparing the results of both of the genres.

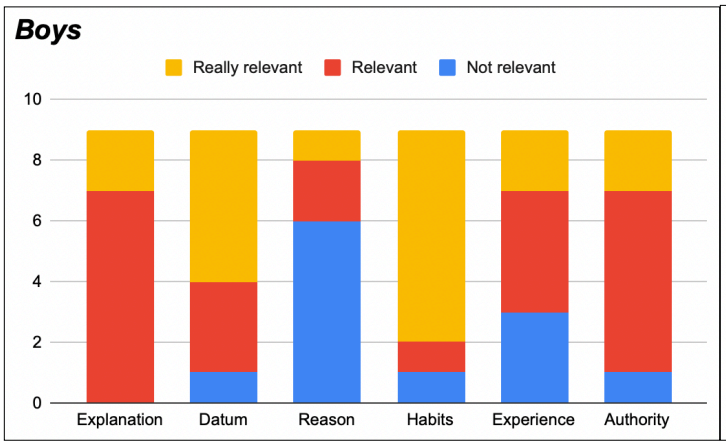

Figure 1. Depicts the boys' credibility in relation to several sources of arguments.

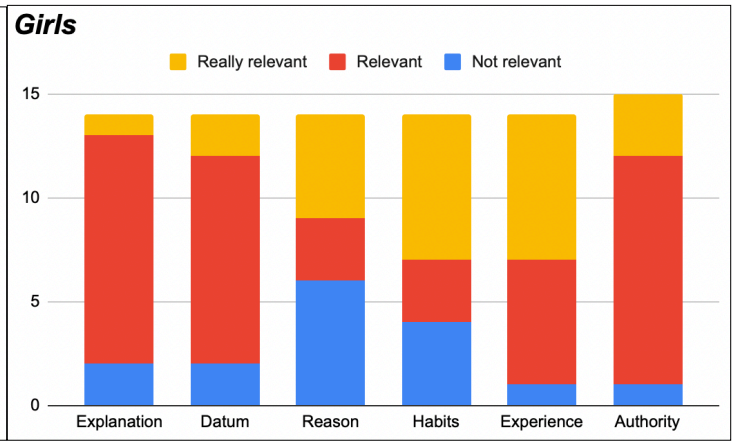

Figure 2. Depicts the girls' credibility in relation to several sources of arguments.

As seen in Figure 1, none of the boys rejected the idea of using the **explanation** resource when sustaining their ideas or beliefs. On the contrary, they see this source as a highly trustworthy one. As is shown in the graphic, 77.8% of the boys believe this source to be trustworthy. On the other hand, if we have a look at the girls' results (Figure 2), it is seen that 78.6% of them believe that this source is highly trustworthy when giving an argument. However, there is a small percentage of 14,3% that believes that explanations are not the most reliable resource to use when exposing their arguments.

The use of **data** in an argument was the second source of argument that the students were asked to assess for credibility. There is a significant disparity between males and girls in this aspect. Regarding the impact on the boys (Figure 1), 55.6% of them think that citing facts in a speech has an important impact on what is said. The minority of the class, merely 11.1%, holds that it is not relevant enough to the credibility of an argument. On the other hand, the females (Figure 2) appear to lack clarity, as evidenced by the fact that 71.4% of them believe that providing information during an argument is moderately reliable. However, it is interesting to point out that there are a number of girls who claim that providing data is extremely trustworthy and that providing that data is insufficiently dependable, with a 14.3% in both circumstances.

Furthermore, as seen in Figure 1, the students also assess the trustworthiness of their ideas or beliefs by using **habits** as an argument. In such situation the majority of the boys (77.8%) were highly confident to assume that mentioning customs or habits that are considered normal while presenting an argument is extremely dependable (Figure 1). However, only a small percentage of the other pupils consider it untrustworthy. Conversely, the girls' results (Figure 2) demonstrate that a greater majority of girls than boys do not feel that this source is trustworthy enough to counter an argument.

Furthermore, the **experience** was another source when giving arguments that the students had to value. In this case, in the boys' graphic (Figure 1), there is a big disparity between the ones that believe that this source is moderately trustworthy and the ones that affirm that this source is unreliable. A small percentage of them believe this is something completely reliable.

For what it does to girls, Figure 2 shows that they highly value this method, with just 7.1% of students rating it as unreliable. However, there is competition among students who feel that using the experience is a very trustworthy method and those who believe the opposite, which happens the same in boys. Moreover, it is interesting to see that among the large number of girls who believe this method is reliable, only 22.2% of them consider it to be completely trustworthy.

In terms of one's own **reasoning** via associating concepts, there is a surprising variation between girls and boys in their perspective on their reliability when giving an argument.

For what it does to males (Figure 1), it is really interesting to see how the majority of them feel it is untrustworthy to make an argument based on personal reasoning. Meanwhile, a minority feels it is extremely trustworthy to use this approach of connecting ideas while expressing oneself.

On the other hand, while many girls (Figure 2) feel that this strategy is insufficiently credible, a larger number of them, compared with the boys, believe that it is extremely trustworthy when presenting an argument.

Finally, pupils were instructed to consider **authority** references when disputing. In this situation, it is noteworthy to see the similarities between the two genres. The majority of students agree that utilizing authoritative references increases the argument's credibility. However, only a tiny fraction of students in both genres believe that this strategy is unreliable for them (Figures 1 and 2).

Overall, boys attributed more trustworthiness to the various aspects than girls, who tended to be more unsure. Boys, in particular, thought that habits were the most reliable aspect of an argument, but girls thought that experience was the most credible one. On the other hand, both boys and girls saw reason as the least trustworthy part overall.

Observation grid of the debate

The pupils were divided into four groups, each with a unique new. They had no guidance on how to convey the information, and the majority of the groups' spokespersons were boys. It is vital to note that the majority of the pupils were girls.

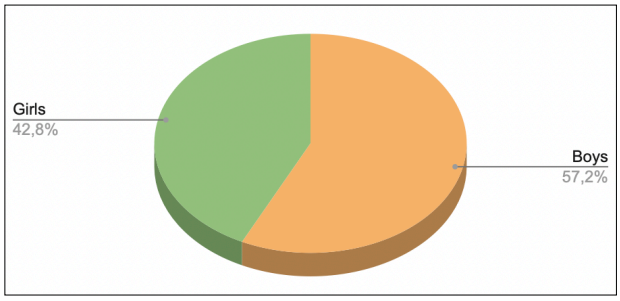

Figure 3. Participation time during the debate.

The debate finally lasted 45 minutes. Even though the girls made up the majority of the pupils in the group, they spoke for an average of 19.44 minutes, compared to 26 minutes for the boys (Figure 3).

Another of the items that was analyzed during the debate was the **type of interventions** that each of the students made every time they spoke up in the debate.

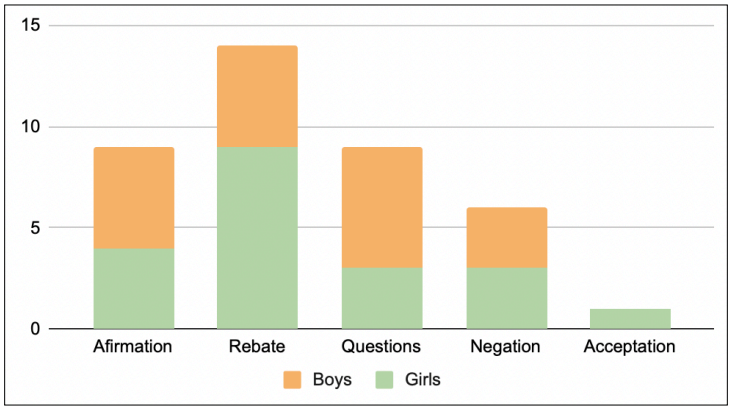

Figure 4. Types of interventions used in the debate.

On the one hand, afirmation was one of the strategies when making an intervention. In this case, guys utilized this method more frequently than girls (Figure 4).

Furthermore, something similar occurred when making questions during debate. Boys (Figure 4) were more likely than girls to utilize questions to get the other team to reflect. Due to this fact, it is evident in the graphic in Figure 4 that the girls tend to make more refutes than the boys.

On the other hand, we can observe (Figure 4) that negation is the only type of intervention in which boys and girls match completely. In here, we can see that both genders use it in the same amount. However, it is important to highlight that acceptance (Figure 4) has only occurred in girls; none of the boys have stopped arguing to accept something that the opposing team would overthrow.

Overall, girls mainly participated by refuting their classmates in the argument, whereas guys primarily questioned them.

Furthermore, the **quality of evidences** they gave when arguing was also analyzed, and the results are shown in Figure 5.

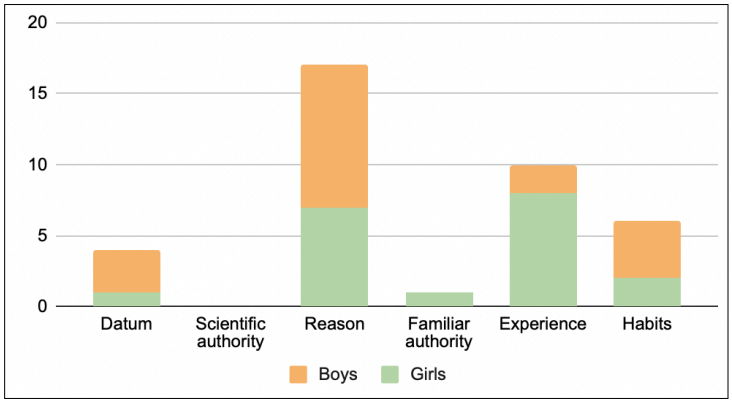

Figure 5. Quality of evidences used in the debate.

It is important to highlight that even though the students were given some time to search for information about the topic to back up their point, none of the pupils used scientific authorities when making their argument. On the other hand, some boys (Figure 5) used some **data** when expressing their opinion, whereas a small percentage of girls used this source.

For what it does to the **experience** (Figure 5), it is important to highlight the big difference between genders. Girls seem to use more experiences and anecdotes to reinforce their argument and thus give it more weight than others. However, only a small number of boys used this strategy.

Nevertheless, the boys showed that they felt more confident when using **reasoning** in their arguments since the number of boys using this strategy is quite high compared to the girls (Figure 5). Furthermore, based on this propensity and what it does to **habits**, we can see that guys utilize it more frequently to reinforce their speech in discussion than girls (Figure 5).

Even so, it is interesting that only girls invoked **familiar authority** (Figure 5), and only a few of them did.

On the other hand, it is important to observe the relationship that both of the items observed during the debate have with each other. So, here there are two recount boxes, depending on the genres, that show up the relationship among both items, types of intervention and quality of the proofs, and which was the most used by the pupils.

	Reason	Experience	Familiar Authority	Habits	Datum
Acceptation	0	0	0	0	0
Afirmation	0	2	1	0	0
Negation	1	2	0	0	0
Question	1	1	0	1	0
Rebate	4	3	0	1	1

Figure 6. Girls' recount box of the analysis between the types of interventions and the quality of the evidences.

As shown and contrasted via colors in Figure 6, girls tend to employ reasoning while arguing with the other team. Additionally, the chart (Figure 6) clearly shows that experiences were one of the most commonly employed refute tactics. Furthermore, the strategy of using experience to make an argument is repeated when affirming or negating (Figure 6). Moreover, it is important to pay attention to the higher concentration of interventions involving reasoning and refutes, as well as experience and refutes, and the wider range of combinations that occur. On the other side, the least commonly employed forms of intervention were familiar authority and datum, followed by habits (Figure 6).

	Reason	Experience	Habits	Datum
Acceptation	0	0	0	0
Afirmation	3	1	1	0
Negation	2	0	1	0
Question	2	0	0	1
Rebate	3	1	0	1

Figure 7. Boys' recount box of the analysis between the types of interventions and the quality of the evidences.

Finally, there are some parallels between what it does to boys and girls, such as the continuous use of reasons throughout a dispute. However, there are significant distinctions. In the first place, Figure 7 shows that, unlike girls, boys employ a lot of reasoning while making affirmations. In contrast to girls, they do not make as many combinations as girls do. They tend to focus their attention on a small number of interventions, which are refutations, affirmations, negations, and questions. It is also vital to note that they do not rely as heavily on experiences as a source of information while arguing. Finally, it is seen (Figure 7) that the boys use a bit more data while asking inquiries than the girls.

6. Discussion

After doing this research, I was able to see in the application of the initial test that the students that I was addressing to did not have a big knowledge of what critical thinking is, neither of which are the different sources of making an argument.

One of the topics I want to discuss is the students' confidence, or lack thereof, in the outcomes of the initial test. For what it does to girls, it is important to notice that they used the word "relevant" multiple times rather than "really relevant." It might be due to a lack of confidence in rating the different sources of information. However, Figure 1 clearly shows the low usage of boys of the "relevant" adjective and the strong use of "really relevant" or "not relevant." In this scenario, guys tend to convey their opinions with extreme adjectives rather than middle adjectives. This might be due to the confidence they have while giving their opinion.

Furthermore, after collecting all of the data, I was curious whether the evidences that the students found important and very relevant in the initial test were the ones they employed the most in the debate. The findings of the test show that males hardly agree that reasoning is a truly significant source of knowledge; instead, the majority of them agree that it is not relevant enough. However, throughout the debate, the guys used the reasoning strategy the most while presenting their arguments. They hardly utilize other sources, which appear to generate a higher level of confidence in them and, as a result, boost the perceived trustworthiness of their argument.

On the other hand, something similar occurred with the girls and their use of reasoning. Some of them felt it wasn't relevant enough, nevertheless they used it frequently during the argument. Furthermore, they employ the source of information that the majority of them previously rated as "really relevant" throughout the discussion, specifically the utilization of experiences to develop an argument. So, in this situation, their behavior throughout the discussion was consistent with their prior beliefs about this source of information.

Prior to the debate, both boys and girls agreed in the test that explanation is a highly recommended technique to build an argument. However, throughout the argument, nobody of them, boys or girls, adopted this strategy. A comparable scenario happened with the application of data and authority references. Both genres agree that these sources were quite useful for developing an argument. However, none of them used these concepts despite the fact that the students had time to carry out research prior to the debate. This might be due to students' lack of familiarity with the process of gathering information.

Furthermore, one of the factors considered while examining the students' debate was the amount of time they spent on their contributions. Gender roles took place here. Despite the majority of the students were girls and made more interventions, the guys' interventions were longer than the one the girls did.

Taking all of this information into account and after the debate, it is important to highlight that even though the girls spend less time talking, they demonstrate to use a wide variety of sources when making arguments, whereas the boys mostly used two different combinations of sources (reasoning + affirmation and reasoning + refute).

It has been seen that a girl have more possibilities to accept the others' arguments whereas the boys rarely will accept other arguments (Julé, 2005). So in here we can see how gender differences influence the communication they employ.

Gender disparities were also observed in the acceptance of other people's arguments. Girls were more inclined to accept battling ideas, implying a more collaborative attitude, whereas guys seldom succumbed to others' arguments, indicating a competitive position. This is consistent with Cook-Gumperz and Szymanski's (2001) results on gender differences in communication styles, which show that females tend to negotiate in group work while guys tend to compete. Helgeson (2017) adds to this by pointing out that females are more likely to offer polite recommendations rather than strong claims, which are often well-received, whereas boys are more likely to interrupt, threaten, and repeatedly state their reasons. As a result, these findings are consistent with prior studies, which found that females tend to accept and perpetuate gender norms while discussing.

In whole-group debates, these dynamics can accentuate disparities in gender because boys may dominate the subject matter through interruptions and repeated claims, whereas girls may feel forced to adhere to polite, non-confrontational positions. This not only reinforces dated gender standards, but also stifles the creation of an equal classroom climate in which all students feel encouraged to contribute completely and truthfully. To promote inclusivity and critical engagement, alternative teaching practices that balance participation and respect different communication styles should take precedence over whole-group debates.

After all, teachers can use a range of different pedagogical tactics to create a more inclusive and critical classroom climate by accommodating varied communication styles. One successful way might be to use small-group conversations in which students may participate more privately and equitably. This environment allows quieter pupils to engage without feeling the strain of a huge audience. Another successful technique that I had seen during my teaching practices is the think-pair-share exercises, which allow students to create their opinions privately before debating them with a partner and finally sharing them with the entire group. Additionally, written reflections and online discussion forums can be introduced to give opportunities for students who may be uncomfortable speaking in front of others. These strategies encourage balanced engagement and guarantee that all opinions are heard and respected, resulting in a more inclusive and critical-thinking classroom environment.

Finally, it is necessary to acknowledge the several limitations that I encountered throughout this small-scale investigation. One of the most significant limitations was the sample's insufficient understanding of information gathering, critical thinking, and how to employ the various critical thinking skills. It was not a class where students were instructed to work hard on critical thinking or debating abilities. This made it harder for kids to self-regulate and necessitated higher scaffolding with various added supports to carry out the different tasks. Furthermore, watching a discussion may be stressful since there are so many different inputs and hence a lot of information. I requested assistance from my teacher to ensure that no details were overlooked in the argument observation. However, it proved to be an obstacle because she was not as familiar with the subject and concepts as I was.

7. Conclusion

In conclusion, the purpose of this study is to examine the students' relationships in science class, specifically the gender differences in their critical thinking skills to examine how the performance of gender roles can affect students' critical thinking skills. As I approach the end of this investigation, it is necessary to clarify what critical thinking skills are all about. Critical thinking skills include the capacity to analyze challenging data, assess the trustworthiness and significance of sources, and reach logical conclusions. These abilities include evaluating facts, expressing concepts coherently, and reflecting on own biases. Additionally, critical thinkers use creativity to create and integrate knowledge in novel ways, all while sharing their ideas and engaging in constructive discourse. Together, these abilities help people to think rationally, make informed judgments, and participate intelligently in debates.

The most highlighted findings from this small-scale research in regard to the research question are the following:

Gender inequalities in self-confidence while judging the sources of arguments in the initial test. Girls tend to be less convinced of the credibility of multiple sources, whereas boys are more certain, employing more extreme adjectives when assessing a source as truly relevant or not enough relevant.

However, there is a lack of coherence with the boys' prior viewpoints. During the debate, the boys end up focusing on a single source of information, despite their earlier negative judgments about the source's credibility. However, this might be attributed to the sample's insufficient understanding of acquiring information and putting it into practice during a debate.

This also results in disparities in the communication techniques of both genders. After reading many articles regarding the issue, I was able to tie what I read to what occurred during the students' debate. It was fascinating to observe guys and their determination to find the truth and, in any event, accept other pupils' arguments, which increased competitiveness. Girls, on the other hand, tend to employ a wider range of sources of arguments to counter the guys' refutations. As a result of the boys' steely determination, they appear to be attempting to defend their ideas in various ways. However, in one case, one girl was unsure how to respond and ultimately accepted the other's argument. This fact again demonstrates how gender roles influence students' talks and confidence.

Furthermore, due to this sense of competitiveness that boys had during the debate, even though girls made more interventions, their time spent talking was lower than that spent by the boys.

Finally, I would like to make some recommendations for the teachers that wants to promote equity in terms of gender in their classes. First of all, ensure that the classroom is a safe environment in which all students feel comfortable expressing their thoughts and opinions, also any incidences of gender-based harassment or discrimination should be addressed immediately and effectively. Moreover, the teacher should reflect on his or her teaching practice and assess his or her teaching techniques and materials for gender bias, like providing diverse role models or having as a reference the MOPC and the EDPAC schemes when programming their classes.

For what it does to the students' active participation, the teacher should encourage the equal involvement by creating opportunities for all the students to participate equally in discussions and activities. Some useful tactics might be the use of think-pair-share or round-robin to make sure every student's voice is heard.

Finally, encouraging kids to actively engage in critical thinking and debates would help them improve their critical thinking abilities while also giving them greater confidence to express themselves freely.

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Annexes 1: Initial test

DEBERÍAMOS PROHIBIR LA PIROTECNIA, ¿SÍ O NO?

En pocos minutos recibió muchos comentarios de followers a favor y en contra:

1. **miri_miri2** Un estudio publicado en la revista Journal of Hazardous Materials demostró que durante la noche de San Juan se disparan los niveles de plomo, cobre, estroncio, potasio y magnesio. Estos se acumulan y perjudican el medioambiente y las especies que lo habitan. Por lo tanto, deberían prohibirse.
2. **mitjavoltaipunt** Un 23% de los perros analizados en un estudio de la Universidad de Oslo reportan miedo a los ruidos, y los petardos y los fuegos artificiales son los principales causantes del terror, por encima de otros ruidos como los disparos, los truenos o el ruido del tráfico.
3. **katk** No deberían prohibirse los fuegos artificiales porque son una tradición que ha ido pasando de generación en generación y está presente en muchas culturas.
4. **silvifrich** Si algunos metales son tóxicos para la salud, entonces es evidente que respirar los humos de los fuegos artificiales es peligroso, ¿no?
5. **ameygou** La perra de una amiga mía sufrió una parada cardíaca por culpa de los petardos. Esta y otras experiencias de mascotas que conozco simplemente me impiden creer que la pirotecnia puede defenderse.
6. **ammanana** Se deberían prohibir los fuegos artificiales porque emiten humos compuestos por partículas de elementos metálicos que pueden perjudicar a la salud humana y sobretodo la de persones asmátiques.

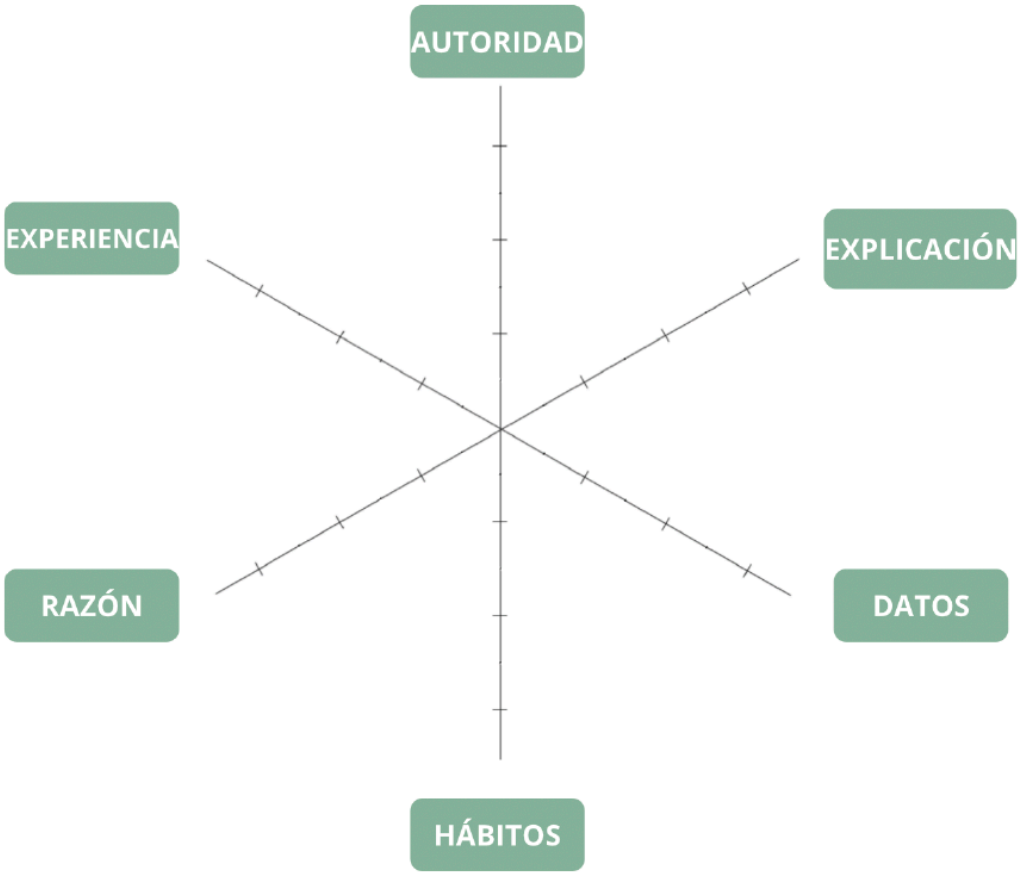
1- Cada uno de estos comentarios lo justifica a partir de algún motivo basado en las fuentes siguientes:

Fuente	Descripción	Comentario del follower
Autoridad	Alguien de importancia (persona, universidad, institución) que lo afirma.	1
Explicación	Explicación de cómo sucede el hecho	6
Datos	Se hace referencia a datos numéricos, estadísticas, gráficos…	2
Razón	Se obtiene a través del razonamiento propio a partir de relacionar ideas	4
Hábitos	Se refiere a costumbres o hábitos que se han convertido en normales	3
Experiencia	Hace referencia a experiencias vividas	5

2- Valora cada uno de los comentarios, del 1 al 3, según el grado de confianza que atribuyas a la fuente citada (el 1 siendo poco fiable y el 3 muy fiable):

Autoridad	Explicación	Datos
Razón	**Hábitos**	**Experiencia**

3- Ahora completa la gráfica con los números que has puesto en la gráfica anterior i unelos.



Annexes 2: Observation grid

TYPES OF INTERVENTIONS:

1. Question
2. Afirmation
3. Negation
4. Refute
5. Aceptation

STUDENT	TIME OF PARTICIPATION	TYPES OF INTERVENTIONS	QUALITY OF THE EVIDENCES	NOTES

QUALITY OF THE EVIDENCES:

1. Datum
2. Cientific authority.
3. Razón
4. Experience
5. Familiar authority
6. None

Annexes 3: MOPC and EDAPC schemes