EVALUATION OF THE SCIENTIFIC REASONING SKILLS OF GRADE SIX PUPILS IN AMAI-PAKPAK CENTRAL ELEMENTARY SCHOOL, MARAWI CITY

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ABSTRACT

This study investigated the scientific reasoning skills of 291 sixth-grade students at Amai-Pakpak Central Elementary School (APCES) in Marawi City, during the school year 2024-2025. The research aimed to address a critical gap in the literature by evaluating these skills in a specific school context, providing valuable insights for educators and policymakers to enhance science education and promote scientific literacy. The study utilized an adapted version of Lawson's Classroom Test of Scientific Reasoning (LCTSR). The study also examined the cognitive development stages based on Piaget's theory and its potential impact on scientific reasoning abilities. It employed a descriptive research design, utilizing the LCTSR to gather quantitative data. The findings revealed concerning scientific reasoning skills among the students. The participants demonstrated the highest proficiency in conservation of weight (72.0%), while their performance in other areas, such as conservation of volume (33.2%) and proportional reasoning (21.2%), was significantly lower. Notably, critical reasoning skills like identification and control of variables (17.9%), probabilistic thinking (17.9%), and hypothetical-deductive reasoning (17.1%) showed alarmingly low scores. In terms of students' levels of scientific reasoning skills, the study also recorded that 81.4% of students were functioning at the concrete operational stage, indicating a reliance on concrete experiences and a struggle with abstract reasoning.

Keywords: Scientific Reasoning Skills, Reasoning Skills

INTRODUCTION

The understanding and developing scientific reasoning skills in young learners was crucial for the Philippines, given its consistent low performance in international assessments like the Programmed for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) (OECD, 2022). The Philippines' lagging performance in mathematics and science highlighted the urgent need to strengthen the foundation of scientific reasoning among Filipino

students. Developing robust scientific reasoning skills was crucial for fostering critical thinking, problem-solving, and informed decision-making—essential skills for success in the 21st century (Cordon & Polong, 2020). While numerous studies investigated scientific reasoning in older students and adults (Smith et al., 2014; Johnson et al., 2014), the specific developmental needs and characteristics of 6th graders remained relatively under-explored. This research gap presented a valuable opportunity to investigate the cognitive and conceptual development of scientific reasoning during this crucial period of education. Understanding the specific challenges and strengths of 6th graders would allow for the development of targeted interventions and instructional approaches to effectively enhance their scientific reasoning abilities (Brown et al., 2014).

This study's focus on Amai Pakpak Central Elementary School (APCES), filling a critical gap in the existing literature, and simultaneously addressing the practical need for effective science education at this crucial developmental stage. This study intends to assess the scientific reasoning skills of 6th graders. Specifically, this study endeavors to answer the following questions: 1. What is the existing scientific reasoning skills of 6th-grade pupils in Amai-Pakpak Central Elementary School based in Lawson's Classroom Test Scientific Reasoning (LCTSR) dimensions such as conservation of weight, conservation of volume, proportional reasoning, control of variables, probability, correlational reasoning, and hypothetical-deductive reasoning. 2. Identify the Piagetian cognitive level of scientific reasoning skills of the respondents based on LCTSR such as: concrete operational, transitional, and formal operational. 3. Are the following factors do participants perceive to affect their scientific reasoning skills? Learning environment, technology/media, school facilities, study habits, peer influence, gender, teachers, and family monthly income. 4. Why do perceived factors affect their scientific reasoning skills?

METHOD

The study focuses on evaluating the scientific reasoning skills in elementary school children, specifically 6th-grade students. The scope of the study involves 6th-grade students enrolled in the school year 2024-2025 during the 1st quarter from Amai-pakpak Central Elementary School, Marawi City, aiming to capture a diverse range of participants to ensure a representative sample. They consist of 291 (136 males and 155 female). Data collection will involve quantitative and qualitative methods, such as administering the LCTSR assessment, interview and observation respectively. The quantitative aspect involves measuring the scientific reasoning skills of 6th-grade students in Amai-Pakpak Central Elementary School with the use of adapted classroom test of scientific reasoning, multiple choice version revised edition by Anton E. Lawson (2000). The qualitative component includes interviews and observations to evaluate what perceived factors affecting their scientific reasoning skills.

FINDINGS AND DISCUSSION

To assess the scientific reasoning abilities of 6th-grade pupils, the researcher often utilized the Lawson's Classroom Test of Scientific Reasoning (LCTSR), developed by Dr. Anton E. Lawson. It is widely used in educational settings to evaluate a student's understanding of key scientific reasoning concepts.

Scientific reasoning skills of 6th-grade pupils in (LCTSR) dimensions

The LCTSR assesses a range of reasoning skills, including the ability to understand conservation of mass and volume, apply proportional reasoning, identify and control variables in experiments, think probabilistically, understand correlations between variables, and engage in hypothetical-deductive reasoning. By evaluating student performance on these dimensions, educators can gain a comprehensive understanding of their scientific reasoning abilities and tailor instruction accordingly. This information can help educators identify students who may need additional support in developing their scientific reasoning skills and provide them with targeted interventions.

Table 1: Performance on Scientific Reasoning Skills in every Dimensions

Dimension	Item Number	Number (%) of students who have the correct answer
Conservation of Weight	1,2	419(72.0%)
Conservation of Volume	3,4	193(33.2%)
Proportional Reasoning	5,6,7,8	247(21.2%)
Identification and control of variables	9,10,11,12,13, 14	312(17.9%)
Probabilistic Thinking	15,16,17,18	208(17.9%)
Correlational Thinking	19,20	163(28.0%)
Hypothetic-deductive reasoning	21,22,23,24	199(17.1%)

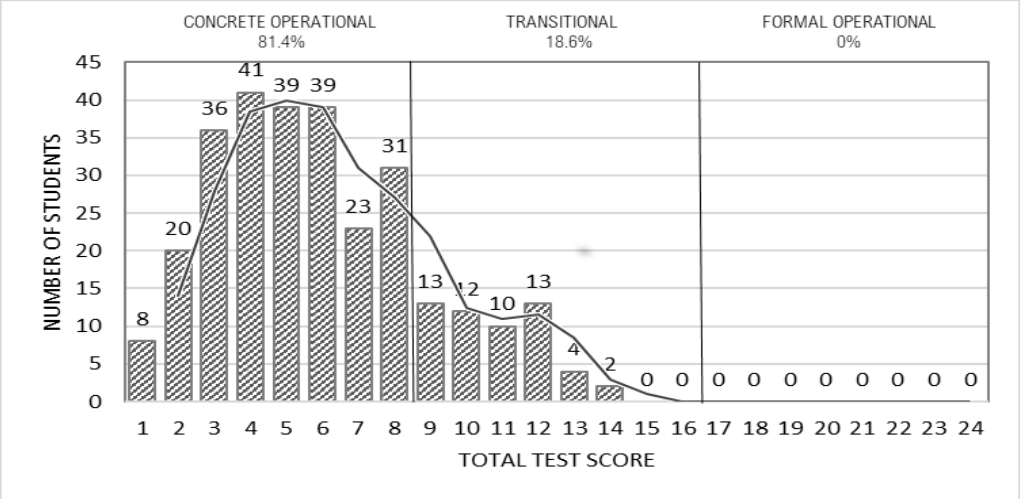
Piagetian cognitive level of scientific reasoning skills of the pupils

To determine the students' level of scientific reasoning skills, scores on the LCTSR were categorized according to Piaget's stages of cognitive development. These stages, which reflect the progression of reasoning abilities, were operationalized as follows: scores ranging from 1 to 8 were categorized as "concrete operational," scores from 9 to 16 as "transitional," and scores from 17 to 24 as "formal operational." This categorization allowed for a more nuanced understanding of the students' reasoning abilities beyond simply reporting their overall scores (Tereza & Lukas, 2014).

Table 2: Distribution of Participants Across Piagetian Cognitive Developmental Levels

Range of Score in LCTSR	Level of Scientific Reasoning Skills	Number(%) of Students
1-8	Concrete Operational	237(814%)
9-16	Transitional	54(18.6%)
17-24	Formal Operational	0

Figure 1: Histogram of the Total Test Scores with a Density Estimate to Smooth the Distribution Shows that the Third Quarter of the Students Fall into the Lowest Piagetian Level of Concrete Operational Reasoning



These findings underscore the importance of providing targeted support for the development of scientific reasoning skills during the early stages of education. Educators can utilize a variety of strategies, such as hands-on activities, concrete examples, and scaffolding, to help students develop their reasoning abilities and prepare them for more complex scientific inquiry in later grades (Lawson, 2020).

To support the quantitative data obtained from Lawson's Classroom Test of Scientific Reasoning (LCTSR) in Table 1 and Table 2, a qualitative component was incorporated into the study through a series of observational checklists. These checklists, designed to assess specific aspects of scientific reasoning, consisted of three distinct activities, each accompanied by a corresponding checklist. The researcher directly observed the students' performance during these activities, recording "observed" if they demonstrated the desired scientific reasoning skills and "not observed" if they did not. This qualitative approach aimed to provide a more nuanced understanding of the students' reasoning processes beyond

the standardized test scores.

Table 3: Observed Thinking Indicators Across Three Activities (in CM, CV, PR, ICV, PT, CT, HDR and Total)

Thinking Indicator Responses (n=30)	**Activity 1**		**Activity 2**		**Activity 3**		**Total(%)**	
	Obs.	***Not obs.***	***Obs.***	***Not obs.***	***Obs.***	***Not obs.***	***Number (%) Observed***	***Number (%) Not observed***
C	19	11	19	11	20	10	58(64.4%)	32(35.6%)
PR	14	16	15	15	24	6	53(58.9%)	37(41.1%)
ICV	15	15	13	17	20	10	48(53.3%)	42(46.7%)
PT	18	12	9	21	12	18	39(43.3%)	51(56.7%)
CT	15	15	13	17	14	16	42(46.7%)	48(53.3%)
HDR	6	24	8	22	16	14	30(33.3%)	60(66.7%)

Note: Obs.- Observed, not obs.- Not observed, C-Conservation, PR-Proportional Reasoning, ICV-Identification and control of variables, PT-Probabilistic Thinking, CT- Correlational thinking, HDTR- Hypothetic-deductive reasoning, Total – Total test score

Factors affecting their scientific reasoning skills.

This study explored the factors that might have influenced sixth-grade students' scientific reasoning skills, examining a range of aspects that could have impacted their learning. The investigation delved into factors such as the learning environment, technology and media use, school facilities, study habits, peer influence, gender, teacher practices, and family income. By examining these factors, the study aimed to identify the most significant influences on students' scientific reasoning abilities.

Table 4: Influence of Factors on Scientific Reasoning Skills

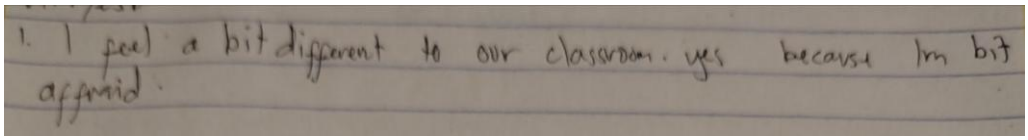
Factors affects their scientific reasoning skills	**Responses (n=30)**	
	Yes(%)	***No(%)***
Learning Environment	18(60%)	12(40%)
Technology/Media	20(66.7%)	10(33.3%)
School Facilities	0(0%)	30(100%)
Study habits	4(13.3%)	26(86.7%)
Peer Influence	10(33.3%)	20(66.7%)
Gender	15(50%)	15(50%)
Teachers	8(26.7%)	22(73.3%)
Family Monthly Income	8(26.7%)	22(73.3%)

Reasons affect their scientific reasoning skills

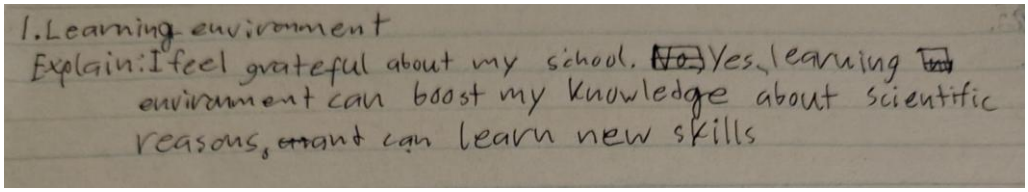
The written responses provided valuable insights into the students' self-perceptions of the factors influencing their scientific reasoning skills, offering a more nuanced understanding of their individual learning experiences and challenges.

Figure 2: Learning environment factor affecting scientific reasoning skills

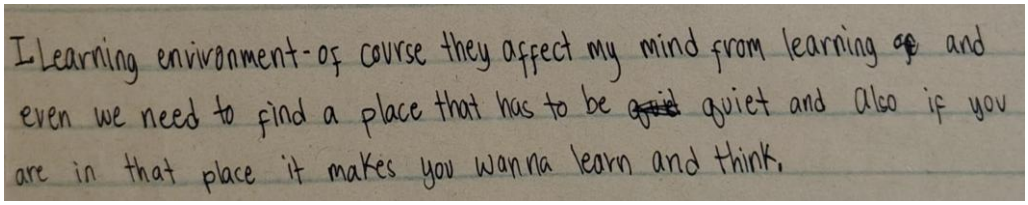
Researcher: How do you feel about your classroom and school? Do you think you're learning environment affect your scientific reasoning skills?



Respondent 16: I feel a bit different to our classroom. Yes, because I'm a bit afraid.



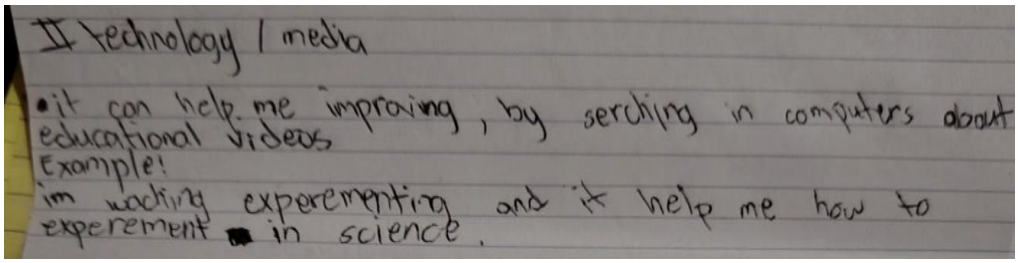
Respondent 19: I feel grateful about my school. Yes, learning environment can boost my knowledge about scientific reasoning and can learn new skills.



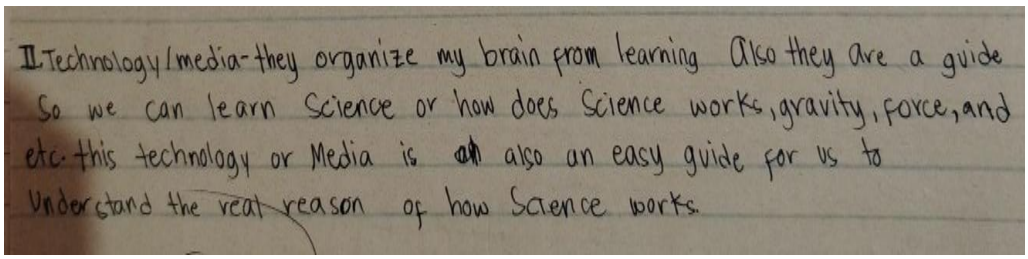
Respondent 21: Of course they affect my mind from learning and even we need to find a place that has to be quiet and also if you are in that place it makes you want to learn and think.

Figure 3: Technology/media factor affecting scientific reasoning skills

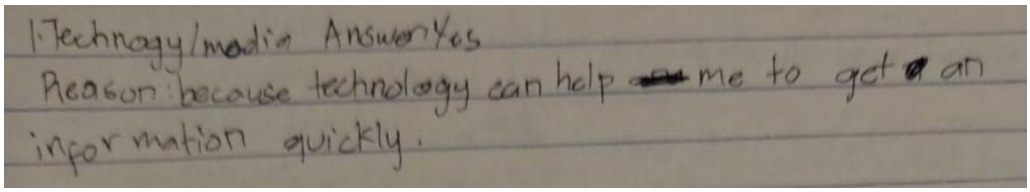
Researcher: How does using technology or media, like computers or educational videos, help you in improving your scientific reasoning skills?



Respondent 8: It can help me improving, by searching in computers about educational videos. For example: I'm watching experimenting and it help me how to experiment in science.



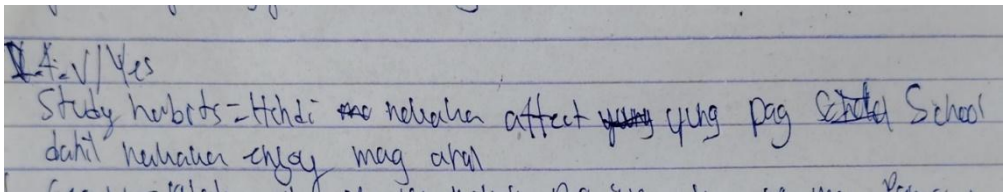
Respondent 21: They organize my brain from learning. Also, they are a guide so we can learn science or how does science works, gravity, force, and etc. This technology or media is also an easy guide for us to understand the real reason of how science works.



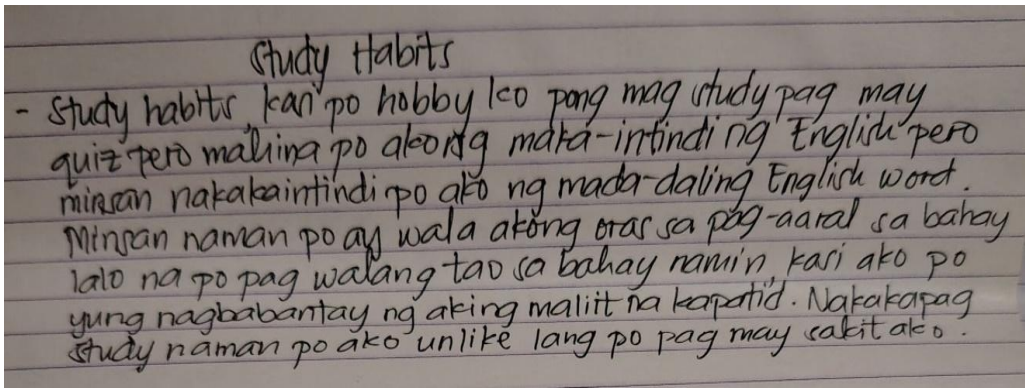
Respondent 30: Technology can help me to get an information quickly.

Figure 4: Study habits factor affecting scientific reasoning skills

Researcher: How do your habits help you understand and apply scientific concepts? Give an example of a specific study habit and explain how it helps you in improving your scientific reasoning skills.



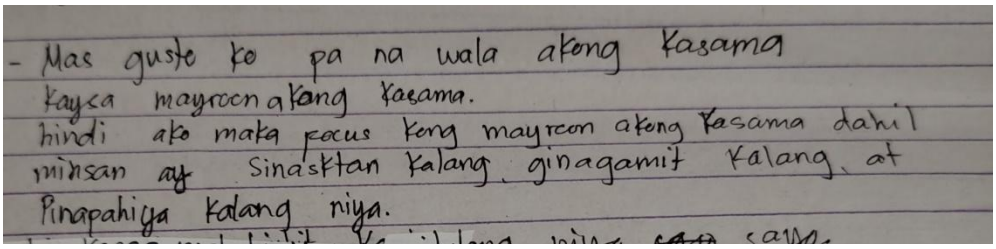
Respondent 5: Hindi nakaka affect yung pagschool dahil nakaka-enjoy mag-aral. (Schooling doesn't feel like a burden because I enjoy learning.)



Respondent 9: My hobby is to study when I have a quiz. Yet, I'm slow in understanding English. Sometimes, I don't have a time to study, especially when no one home because I'm the one who looks after my sibling.

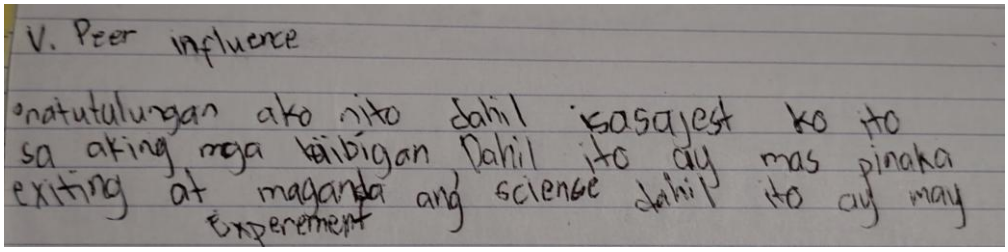
Figure 5: Peer influence affecting scientific reasoning skills

Researcher: How does discussing scientific ideas with your classmates help improve your own understanding and reasoning skill?



Respondent 1: Mas gusto kopa na wala akong kasama kaysa mayroon akung kasama. Hindi ako makafocus kung mayroon akong kasama dahil minsan ay sinasaktan kalang... (I prefer that I have no one with me than

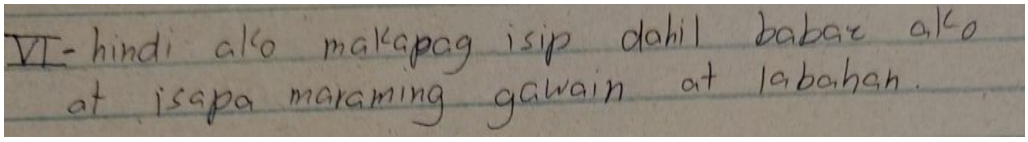
to have someone with me. I can't focus if I have someone with me because sometimes they just hurt you...)



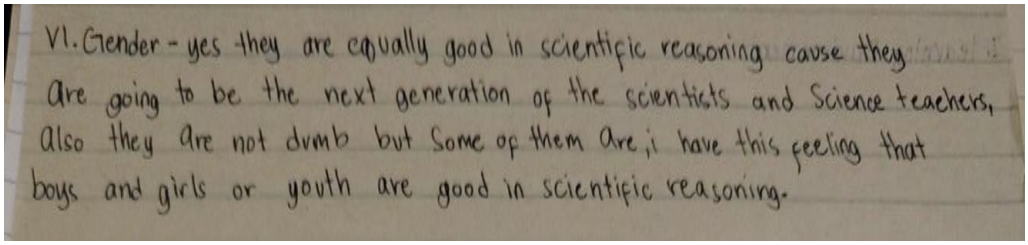
Respondent 8: Natutulungan ako nito... Ito ay mas pinaka exciting at maganda ang science dahil ito ay may experiment. (This helps me... This is the most exciting and beautiful science because it has experiments.)

Figure 6: Gender factor affecting scientific reasoning skills

Researcher: Do you think boys and girls are equally good in scientific reasoning skills? Why or why not.

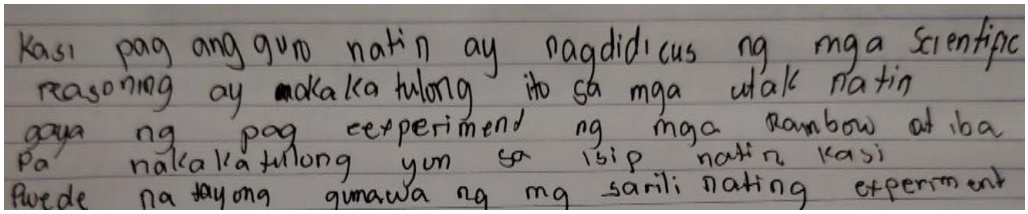


Respondent 18: hindi ako makapag-isip dahil babae ako at isapa maraming gawain at labahan. (I can't think because I am a woman and there are many chores and laundry.)

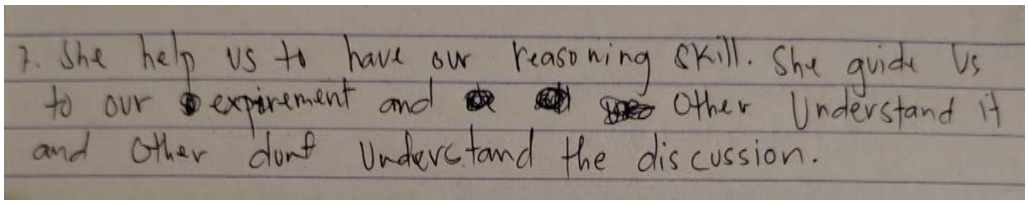


Respondent 21: Yes, they are equally good in scientific reasoning because they are going to be the next generation of the scientists...

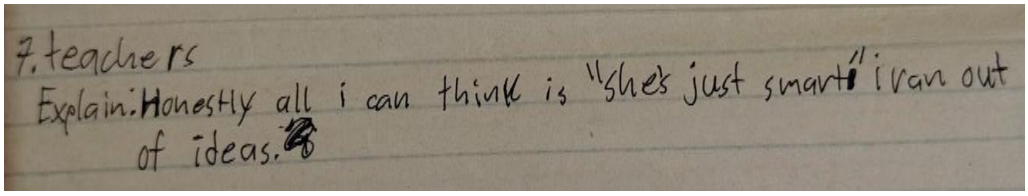
Researcher: How does your science teacher help you develop your scientific reasoning skills? Can you provide a specific example of an activity or lesson where your teacher guided you think like a scientist?



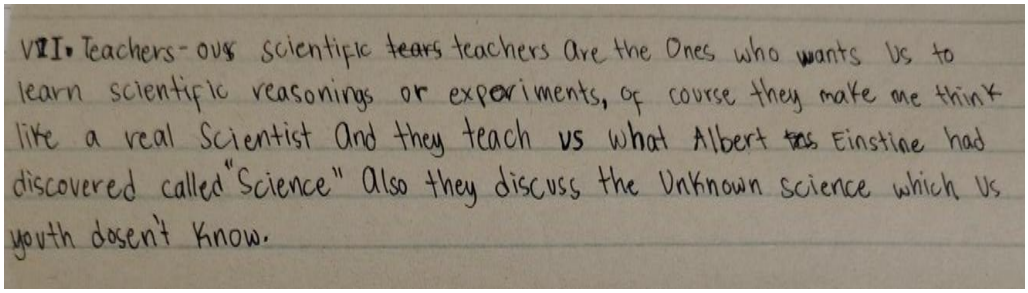
Respondent 4: Pag ang guro ay nagdidiscuss... Nakakatulong ito sa mga utak natin gaya ng pag experiment... Nakatutulong yon sa isip natin kasi pwede na tayong gumawa ng mga sarili nating experiment. (When the teacher is discussing... This helps our brains like experimenting... That helps our minds because we can now create our own experiments.)



Respondent 16: She help us to have our reasoning skills. She guides us to our experiment..



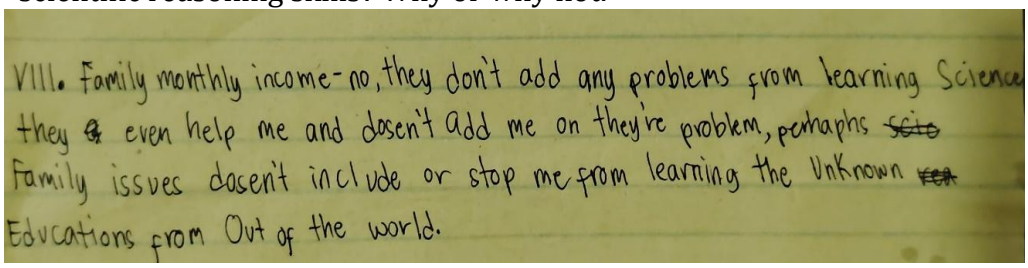
Respondent 19: Honestly, all I can think is "she's just smart" I ran out of ideas.



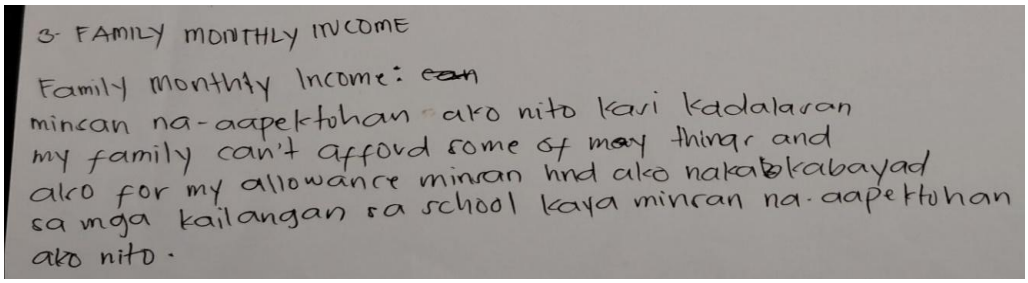
Respondent 21: Teachers l, are the ones who wants us to learn scientific reasoning or experiments, of course they make me think like a real scientist...

Figure 7: Family monthly income factor affecting scientific reasoning skills

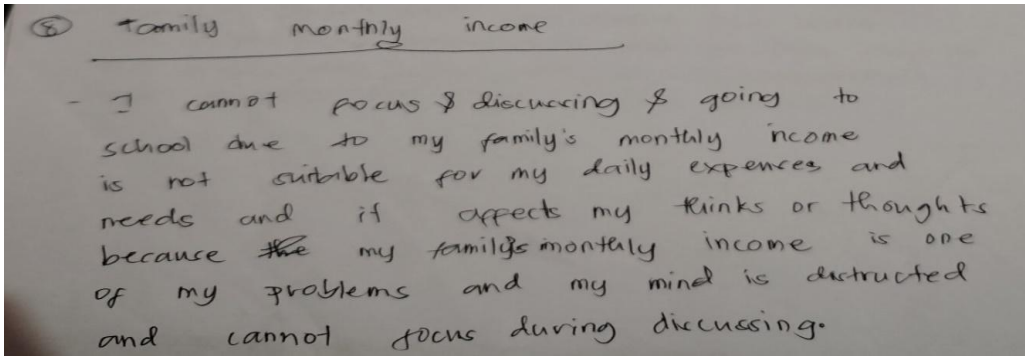
Researcher: Do you think your family's income has any effect on your scientific reasoning skills? Why or why not.



Respondent 21: No, they don't add any problems from learning science. They even help me and doesn't add me on they're problem. Perhaps family issues don't include or stop me from learning the unknown educations from out of the world.



Respondent 28: Minsan naaapektuhan ako nito kasi kadalasan my family can't afford some of my things and also for my allowance minsan hindi ako nakakabayad sa mga kailangan sa school kaya minsan naaapektuhan ako nito. (Sometimes I am affected by this because often my family can't afford some of my things and also for my allowance sometimes I can't pay for the things needed in school so sometimes I am affected by this.)



Respondent 29: I cannot focus in discussing and going to school due to my family's monthly income is not suitable for my daily expenses and needs and it affects my thinking... My mind is distracted and cannot focus...

CONCLUSION

The examination of existing scientific reasoning skills using Lawson's Classroom Test of Scientific Reasoning (LCTSR) revealed that while students showed the highest proficiency in conservation of mass at 72.0%, their performance in other key areas, such as conservation of volume (33.2%) and proportional reasoning (21.2%), was significantly lower. Alarmingly, critical reasoning skills such as identification and control of variables, probabilistic thinking, and hypothetical-deductive reasoning were notably deficient, with average scores around 17.9% and 28.0%. While the Piagetian levels of reasoning among the students further underscores the importance of tailored educational support. A staggering 81.4% of students were identified as functioning at the concrete operational stage, indicating a strong reliance on concrete experiences and a struggle with abstract reasoning. Only 18.6% exhibited transitional reasoning, and none demonstrated formal operational reasoning. Furthermore, the study identified several factors perceived by students to influence their scientific reasoning skills, with the learning environment and technology/media usage emerging as the most significant. While other factors, such as peer influence, gender, teacher practices, and family income, were also recognized, their impact appeared less pronounced than that of the learning environment and technology. Thus, it is crucial for educators to prioritize creating stimulating and interactive settings, effectively integrating technology into learning, and supporting students' study habits to enhance their scientific reasoning skills.

ACKNOWLEDGEMENT

I am grateful to God for the wisdom and knowledge He has given me, knowledge I never knew I possessed. Allah has also sent me people to motivate and help me throughout this process. Many people came and went, but I swear, they all motivated me to finish this paper. Especially my family, my parents Omekulay and Abekulay, who always wished for my success. I also want to thank our Chairperson, Prof. Indad, Prof. Nafisah and my panels who helped me done my thesis. Also, my husband, whose unwavering support and love have kept me motivated.

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