Learning Through Argumentation In Elementary Science For Improved STEAM And Higher-Order thinking Skills

Melissa A. Torregoza[1], John Vincent C. Aliazas[2]
[1,]San Antonio Elementary School, SDO Sto. Tomas, Sto. Tomas City, Philippines
[2]Teacher Education Department, Laguna State Polytechnic University, Philippines

Abstract- *This study was specifically focused on determining the effect of learning through an argumentation approach to the STEAM skills and the higher-order thinking skills of the grade 5 pupils at San Antonio Elementary School for the school year 2022-2023.The study utilized an experimental pretest-posttest research design. The researcher utilized a class of respondents, which were composed of 30 pupils. The pretest and posttest teacher-made instruments consisted of thirty (30) item tests that included questions that assessed the STEAM skills and HOTS. A T-test was used to determine the significant differences before and after the treatment. The result suggests that when learners are exposed to argumentation activities, they tend to be more critical in assessing ideas. Moreover, learners are more likely to be better communicators and problem-solvers. Argumentation also fosters creativity because respondents tend to deviate from conventional approaches for their ideas and opinions to be understood better. Furthermore, in terms of HOTS, data reveal that learning through argumentation can be an effective approach to enhancing the ability of learners to analyze and evaluate ideas, whether orally or in writing.Finally, there are significant differences between the pretest and posttest scores of the respondents as to their STEAM skills in critical thinking, creativity, communication, and problem-solving and higher-order thinking skills in analyzing and evaluating.Since it was found that learning through argumentation is effective in improving STEAM skills and HOT skills, it is recommended that this approach be used in subjects that demand these skills. Other researchers may utilize more specified assessments targeting STEAM and higher-order thinking skills to further explore the approach's effectiveness. Since some skills are multifaceted, assessments will be vital in arriving at more conclusive results.*

Keywords- Argumentations approach, STEAM skills, Higher-order thinking skills,

I. INTRODUCTION

In the recent educational context, arguing is not a new approach to effectively yield learning to students. It is a prevalent culture for people nowadays to argue even outside school. Young generations love to argue and are very fond of correcting people, especially on social media (Bautista et al., 2021). This characteristic of Gen Z can catapult learning by posing arguments in class(Koulopoulos & Keldsen, 2016). Since they are very outspoken and opinionated, lessons can be structured so that learners will have to argue, whether in writing or debating.

Many people thought that arguing hampers the realization of the lessons' objectives. In contrast to this belief, arguing has been proven to increase learners' scientific and thinking skills. In argumentation, concepts or opinions are supported by strong and concrete thinking abilities(Yacoubian, 2015). One can persuade others or spread knowledge across several platforms through argumentation. It supports the exchange of ideas and perspectives and the resolution of various problems. Using argument platforms, students can learn to think critically and reason differently (Malik, 2018). It can give us the ability to solve problems like answering inquiries, passing judgment, and coming to conclusions. Argument teaches learners to assess opposing arguments, analyze supporting data, and evaluate investigative techniques (Lam et al., 2018). Furthermore, it allows students to express their ideas clearly and precisely. Arguments also respectfully and critically evaluate the opinions of others (Osborne et al., 2016).

Argumentation should be a combination of cognitive and linguistic skills. With contrasting ideas posed in a science subject, arguments can be an effective methodology to harness forthright learners. Students' knowledge is enhanced when the argument is integrated with science subjects (Ping et al., 2020). As constructivists say, argumentation is connected to conceptual transformation (Kukla, 2013). As they create an argument supported by evidence, it improves students'

comprehension of the subject matter and develops their skills. Students can analyze, defend, and evaluate their own and others' arguments as they build their collective knowledge (Fernando& Marikar, 2017. In addition, arguments give more pupils a chance to speak up in class. Students externalize their ideas as they apply their scientific knowledge to create meaning and offer justification. Students may agree on a topic or maintain various opinions (Yu, 2022). This emphasizes science as a mode of thinking rather than just a collection of ideas and information. Since science comprises different ideas and conflicting theories, argumentation may effectively enhance learners' STEAM Skills and higher-order thinking (Ridwan et al., 2017).

Many studies have shown that learners should not only possess 21st-century skills but STEAM skills as well for them to be effective innovators of the future. In STEAM, educators can engage students early in the arts and sciences and foster a love of learning that will last a lifetime (Helm et al., 2023). It is crucial to teach pupils current, in-demand skills that will equip them to be innovators in a world that is always changing, both for their futures and the nation's future (Dogomeo & Aliazas, 2022). STEAM equips instructors with the tools to implement project-based learning that integrates all disciplines and promotes a welcoming learning environment where all pupils can participate and contribute (Krajcik & Czerniak, 2018). As opposed to traditional modes of instruction, STEAM educators integrate the disciplines, taking advantage of the connections between math and science material and the modeling process, for instance, to obfuscate the distinctions between modeling methods and scientific/mathematical reasoning (Kim & Bolger, 2017). This holistic method allows Students to use both sides of their brains at once. Through STEAM, kids are given the tools to be inquisitive learners who look for original answers to problems rather than simply searching the internet, helping them build the soft and hard skills required to thrive in college and their professions (Maslyk, 2016).

On the other hand, since argumentation demands a great level of thinking in terms of weighing circumstances, rebutting, and evaluating shreds of evidence, this approach may be effective in improving higher order thinking skills of grade 5 pupils. The Department of Education seeks to encourage higher-order thinking skills (HOTS) in all of public schools as new 21st-century skills. But it is difficult for learners to gain this expertise (Orozco & Pasia, 2021). As of the 2016 version, the DepEd curriculum guide mandates HOTS for all its learning skills. A concept known as higher-order thinking skills considers the various forms of learning and the various amounts of cognitive processing. It is a means of encouraging kids to think rather than memorize, enhancing their cognitive function. Higher-order thinking skills are presented to us in the form of Bloom's Taxonomy, which provides us with a hierarchy of levels (remembering, understanding, applying, analyzing, evaluating, and creating) (Masapanta-Carrión& Velázquez-Iturbide, 2018).

HOTS include the fourth to sixth levels. The fourth level, analyzing, allows students to dissect material into smaller pieces by determining causes and effects and gathering evidence to back up their conclusions. The fifth level, evaluating, is where students assess the accuracy of the data and determine whether a concept or piece of work is valid. The final level is creating, where students can combine the knowledge they already possess to produce new patterns or fresh approaches. The pupils benefit greatly from these upper levels of Bloom's Taxonomy, which focus on analyzing, evaluating, and creating because they learn to think critically and solve problems (Chinedu et al., 2015). This enables the student to use their knowledge outside the classroom and in their personal lives. These abilities help a child's learning and enable them to apply what they learn outside of the classroom. The pupils will learn why their knowledge benefits their life through these levels. They can use the knowledge to address a problem at work or home, gaining experience. Practices of thinking skills are among the generic abilities that ought to be incorporated into all technical topics. Students with higher-order thinking abilities are better equipped to study, perform better, and experience fewer weaknesses (Savery, 2015).
The researchers believe that STEAM skills and Higher-order thinking of learners can be improved by using argumentation as an approach to teaching-learning. Thus, this research aims to prove this claim.

A. Objectives

The study's primary purpose is to determine the effect of learning through an argumentation approach to the STEAM skills and Higher-Order thinking skills of Grade 5 learners of San Antonio Elementary School. In particular, this study seeks to answer the following questions:

1. What are the mean pretest and posttest scores of the learners in learning through argumentation approach as to their:

1.1. STEAM Skills in terms of:
1.1.1. critical thinking;
1.1.2. collaboration;
1.1.3. creativity;
1.1.4. communication;
1.1.5. problem-solving; and
1.2. Higher Order Thinking Skills in terms of:
1.2.1. analyzing;

1.2.2. evaluating;
1.2.3. creating?
2. Are there any significant differences between the pretest and posttest scores of the respondents exposed to learning through argumentation as to their:
2.1. STEAM Skills in terms of:
2.1.1. critical thinking;
2.1.2. collaboration;
2.1.3. creativity;
2.1.4. communication;
2.1.5. problem-solving; and
2.2. Higher Order Thinking Skills in terms of:
2.2.1. analyzing;
2.2.2. evaluating;
2.2.3. creating?

B. Conceptual Framework

Learning through argumentation is anchored to different perspectives, such as philosophy, literature, and public speaking (Van Eemeren, 2018). Argumentation is a type of conversation in which knowledge assertions are created independently and with others and then assessed in light (Erduran&Jimenez, 2007)

Argumentation Theory (Rapanta &Macagno, 2016) tells that arguments aim to establish standards for evaluating an argument's validity. Some of the earliest academic disciplines deal with describing and analyzing arguments. Aristotle identified several types of reasoning, including didactic, dialectical, examination, and eristic. Scholars who concentrated on the argument's sequential structure dominated the study of argumentation for most of the 20th century. According to this tradition, a strong argument should have a specific structure, and researchers have tried to define the "grammar" of strong arguments by comparing it to the syntax of well-written sentences.

Stephen Toulmin's model (Khambete, 2019) of argumentation provides the framework to sound argumentation. A warrant justifies using the data as support for the claim; a claim states the standpoint or conclusion; data are the facts or opinions that the claim is based on; backing, optionally, provides specific information supporting the warrant; a qualifier adds a degree of certainty to the conclusion, indicating the degree of force, which the arguers attribute to a claim; rebuttals to the assertion are used to state exceptions to it. This analysis framework has had a significant impact, particularly on the study of written argumentation. It is a concise explanation of what seems to be a reasonable course of action or even a fruitful path of inquiry. Complex problems are best solved using Toulmin's method based on logic and in-depth examination.

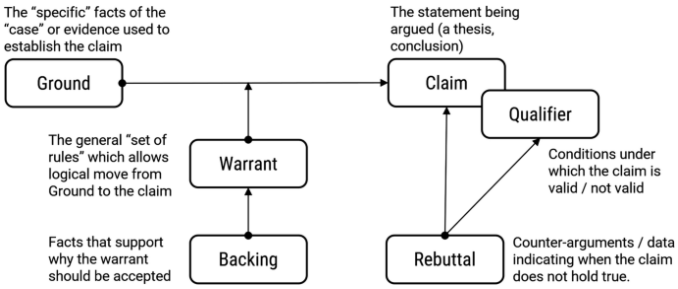

Figure 1. Toulmin's Model of Argumentation (as utilized by Khambete, 2019)

On this matter, proper argumentation in terms of public speaking can be linked to Dialogue theory (Bex& Walton, 2016). A motion made in a conversation in which two parties try to reason together is viewed as an argument. Persuasion, inquiry, negotiation, information-seeking, deliberation, and eristic (personal conflict) are six discourse categories that serve as a normative paradigm for how a certain argument should be employed cooperatively (Manalo & Chua, 2020). Each pair of movements in a discussion after the initial move is referred to as an adjacency pair. Moves in a sequence and formal dialectical frameworks are designed to model various speech acts in addition to the debate. According to dialogue theory, when students argue to learn, they are not primarily aiming to persuade one another but rather are participating in cooperative explorations of a dialogical space of solutions.

Regarding cognitive aspects, argumentation can be anchored to the Theory of Distributed Cognition (Boyle et al., 2023). The goal of distributed cognition, a conceptual framework for thinking about cognition, is to comprehend how component pieces interact to produce the cognitive features of aggregates. It can be applied to cognitive systems at various levels of complexity, from parts of a single brain to social groups. Some people believe that distributed cognition is a distinct kind of cognition that happens when humans interact with one another or with physical objects. This only partially holds. Distributed cognition is not a type of cognition; it is a way of thinking about cognition that enables one to analyze the connections between what is in the mind and the environment in which it exists (Michaelian & Sutton, 2013).

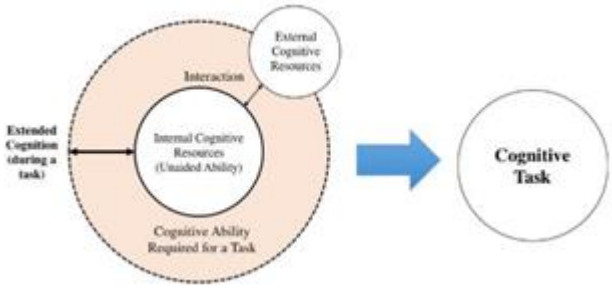

Figure 2. Theory of Distributed Cognition

While traditional cognition researchers concentrate on individual cognitive processes, distributed cognition researchers explore a social system (Boyle et al., 2023). As a result, they focus on a group of people, objects, and their relationships using a broad perspective that incorporates multiple academic fields, including sociology and cognitive science.According to distributed cognition theorists, the cognitive characteristics of a system cannot be fully grasped from the cognitive characteristics of the individual components (Kim, 2018).

The conceptual model depicted in Figure 3 will serve as the guide for this study. The study's variables will fall within the parameters listed in the research paradigm. Referring to the model, the independent variables are Learning through argumentation approaches, including causal evaluative and rebuttal arguments. The dependent variables include STEAM (Science, Technology, Engineering, Arts, and Mathematics) skills such as critical thinking, collaboration, creativity, communication, and problem-solving. Regarding Higher-order thinking skills, this research is limited only to analyzing, evaluating, and creating.

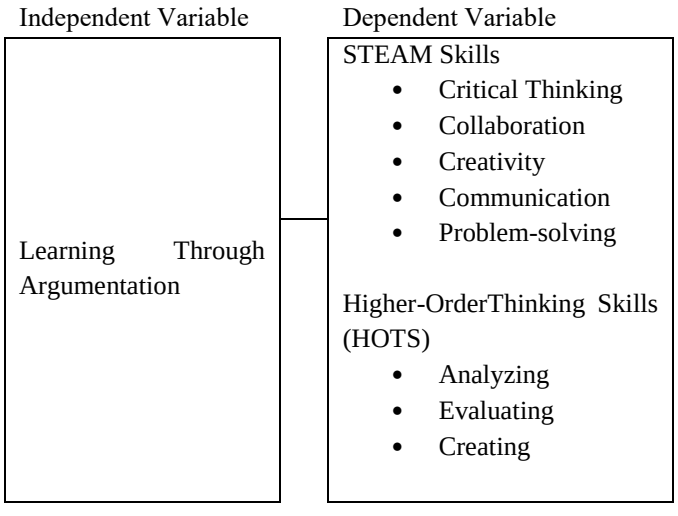

Figure 3.Research Paradigm

II. RESEARCH METHODOLOGY

A. Population and Samples

The subjects of this study were the Grade 5 public elementary pupils at San Antonio Elementary School, Sto. Tomas North District, Division of Sto. Tomas City for the school year 2022-2023. The researcher utilized a single group pretest-posttest designcomposed of 30 pupils each who were purposively chosen based on the learners' availability in the researcher's school.

B. Research Instrument

A pretest and posttest were utilized to gauge pupils' STEAM skills and Higher Order Thinking. The pretest and posttest teacher-made instruments consisted of thirty (30) item tests that included questions that assessed the STEAM skills of the respondents, such as critical thinking, collaboration, creativity, communication, and problem-solving. Also, the tests will measure the higher-order thinking skills of the respondents in terms of their analyzing, evaluating, and creating.

C. Collection of Data

The researcher sought approval from the principal's office before implementing the study. Upon approval, the pretest was fielded to the respondents to measure the initial level of the pupils; STEAM skills (critical thinking, collaboration, creativity, communication, and problem-solving) and higher-order thinking skills (analyzing, evaluating, and creating). After such, the researcher implemented the learning through argumentation approaches in the lesson in Science 5. The respondents were exposed to the activities focused on the Most Essential Learning Competencies for the 3rd quarter in the context of argumentation.

After finishing all the Most Essential Learning Competencies (MELCs) for 3rd Grading period in science 5, a parallel test was administered to determine if the learning through argumentation approach significantly developed the STEAM skills (critical thinking, collaboration, creativity, communication, and problem-solving) and the higher-order thinking skills (analyzing, evaluating, and creating) to the learners.

Once completed, the data and responses were collected. The data were also documented, tabulated, and summarized. Consequently, they were treated and analyzed using the appropriate statistical tool.

D. Data Analysis

The yielded data were gathered, analyzed, and interpreted using descriptive and inferential statistics.The mean and standard deviation were utilized to describe the respondents' performance. On the other hand, a t-test of difference was used to answer inferential questions before and after the treatment with a 0.05 level of significance.

III. RESULTS AND DISCUSSION

Table 1. Mean Pretest and Posttest Scores of the Learners in Learning through the Argumentation Approach in Terms of STEAM Skills

STEAM Skills	Pretest		
	Mean	SD	Verbal Interpretation
Critical Thinking	5.43	1.74	Average Level
Collaboration	4.17	1.90	High Level
Creativity	2.33	1.03	Average Level
Communication	3.80	1.49	Average Level
Problem-solving	4.33	1.73	Average Level
STEAM Skills	**Posttest**		
	Mean	SD	Verbal Interpretation
Critical Thinking	6.33	.84	High Level
Collaboration	4.73	.96	High Level
Creativity	2.87	.43	High Level
Communication	5.17	1.21	Average Level
Problem-solving	5.80	1.06	High Level

Interpretations: Critical Thinking (5.50-7.00 – High Level; 3.50-5.49 – Average Level; 3.49 and below – Low level) Collaboration Skills (3.50-5.00 – High Level; 1.50-3.49 – Average level; 1.49 and below – Low level) Creativity (2.51-3.00 – High level; 1.50-2.49 Average level; 1.49 and below – Low level) Communication (6.50-8.00 – High level; 3.50-6.49 – Average level; 3.49 and below – Low level) Problem Solving (5.50-7.00 – High Level; 3.50-5.49 – Average Level; 3.49 and below – Low level)

Table 1 presents the learners' mean pretest and posttest scores in learning through an argumentation approach in terms of STEAM (science, technology, engineering, arts, and mathematics skills).

In terms of the learners' critical thinking skills, it is observed that the mean pretest score scores of 5.43 (Average) increased to 6.33 (High) in the posttest. This result is aligned with other research that the argumentation approach can improve critical thinking skills. This may be attributed to how learners created and designed their arguments, which enhanced their critical thinking skills. For instance, Gupta et al. (2015) emphasized in their study the positive impact of learning through argumentation in promoting the learners' critical thinking skills.

Furthermore, a study conducted by Forte (2014) suggests that when learners are exposed to argumentation activities the more that they question existing concepts, analyze evidence, and craft scientific-based arguments. The approach provides respondents a chance to question and evaluate circumstances in the classroom and the topics being discussed, thus promoting critical thinking skills. The interactive nature of argumentation as respondents interact in analyzing and evaluating data promotes critical thinking and reasoning (Kim et al., 2014).

In collaboration, the data suggest a slight increase in the mean scores from 4.17 to 4.73. It is observed in the results that respondents have a high level of collaborative skills both in terms of pretest and posttest scores. With a standard deviation of 1.90 and .96, respectively, it can be inferred that the range of the variety of respondents' collaborative skills is wide in the pretest. One reason that may be attributed to the wider collaborative skills is the variety of experiences of the respondents concerning their ability to work with others. Some learners may have already established this skill before applying the treatment, which is why there has been no significant increase in their collaborative skills. Hence, learners' initial "high level" of collaborative skills limits the improvement after the intervention.

Furthermore, not all students are fond of working with others. Due to differences in learning styles, some learners might be uncomfortable dealing with other respondents. Thus, the results may be affected. For instance, in the study of Lorimer (2023), it was noted that independent learners do not excel in collaborative activities. On the other hand, verbal learners excel when they are tasked to group with other students. However, the consistent scores suggest that learning through argumentation effectively nourished the learners' existing high level of collaboration. This might be due to the argumentation activities that the pupils perform in implementing the study.

Regarding creativity, there is a slight increase in the respondents' scores. This may indicate that the creative skills of the respondents were not much affected by the approach implemented. This result can be attributed to the reason that creativity is a multifaceted skill that needs to be gauged using

multiple techniques such as problem-solving, concept mapping, focus group discussion, and the like (Sun et al., 2022).

Furthermore, since creativity is viewed as an innate skill that can be developed through constant practice (Plucker et al., 2004), the learners' foundation in creativity needs to be strong before the onset of the intervention. Since the implementation time was not too long, the creative skills of the respondents were not improved. However, it is important to note that although there is a slight increase in the score, the levels of students' creativity improved from average level to high level.

In communication, the pretest score is 3.80, while the posttest is 5.27. Posing an idea that learning through argumentation may have significantly increased the learners' communication skills. It might be reasoned that arguments require learners to be articulate in sharing their ideas and proving their points in conversing with the class. When learners reason out and debate a certain concept, these may contribute to their communication skills.

Moreover, this study also seeks to improve collaboration, and through this skill, communication is also enhanced. Learners collaborating and interacting pave the way for respondents to improve their communication skills. Also it is also important to underscore that the respondents' collaboration level was categorized as "high level" both in pretest and posttest; thus, the existing skills of the respondents in collaboration might be the reason for the significant increase in the pupils' communication skills.

Lastly, the results in problem-solving skills reveal that learning through argumentation can improve the learners' problem-solving skills. From the average skill level of the respondents (4.33), it was bettered to a high level (5.80), suggesting that the intervention was effective. Through engaging in argumentation activities, pupils may have acquired skills to scrutinize problems and formulate ways to solve them effectively. This is consistent with the study of Seyoum et al. (2022), which highlighted that argumentation encourages learners to analyze and provide multiple ways to solve a problem.

Furthermore, argumentation improves the way learners see and treat problems. Through raising and evaluating arguments, learners acquire different perspectives on problems and how they can be solved. Thus, in return, improving their skills in problem-solving.

Table **2**Mean Pretest and Posttest Scores of the Learners in Learning through the Argumentation Approach in Terms of STEAM Skills

Higher-Order Thinking Skills	Pretest		
	Mean	SD	Verbal Interpretation
Analyzing	7.93	2.35	High Level
Evaluating	5.6	2.24	Average Level
Creating	6.50	2.64	Average Level
Higher-Order Thinking Skills	Posttest		
	Mean	SD	Verbal Interpretation
Analyzing	10.03	1.27	High Level
Evaluating	7.40	1.20	High Level
Creating	6.77	1.14	Average Level

Interpretations: Analyzing (7.1-11.00 – High Level; 4.1-7.00 – Average Level; 4.00 and below – Low level) Evaluating (7.1-10.00 – High Level; 4.1-7.00 – Average Level; 4.00 and below – Low level) Creating (7.1-10.00 – High Level; 4.1-7.00 – Average Level; 4.00 and below – Low level)

Table 2 presents the learners' mean pretest and posttest scores in learning through the argumentation approach in terms of higher-order thinking skills. In terms of analysis, it can be observed that the mean scores increased in the pretest and posttest from 7.93 to 10.03. This suggests a considerable increase in the respondents' analysis skills after they are exposed to learning through the argumentation approach. Furthermore, based on these data, it can be said that learning through argumentation may be an effective approach to enhancing learning analysis skills. Furthermore, it can be reasoned that engaging in arguments allows learners to analyze situations and weigh which concept can stand in a debate. Also, during rebuttal, respondents tend to critically analyze the debater's words and the stand being presented to them. Through this, learners tend to make patterns, establish connections between and among concepts, and scrutinize whether it is good or bad.

Demircioglu et al. (2023) underscore that argumentation activities are crucial in enhancing scientific arguments. It helps learners to evaluate data, draw conclusions, link concepts, and among others. The existing study and the cited idea prove that argumentation is an effective approach to teaching difficult concepts that need extreme analysis.

Regarding evaluating skills, it can be observed that the learners initially showed an average level of evaluation skills with 5.63. However, after the implementation of the intervention, the scores significantly increased to 7.40 which falls on the category of high level. This substantial increase proves that argumentation positively impacted the respondent's ability to assess information, make informed choices, and reject or accept arguments.

Exposing learners to debates, writing position papers, and others, allowed them to assess concepts and contentions as to whether they will accept or reject the claims in the class. The nature of argumentation fostered healthy discussions and collaboration among participants (Noroozi, 2013). In the process, they tend to improve their skills in evaluating.

Regarding creating, the pretest and posttest scores are both falling on the same verbal interpretation "average level." The pretest score is 6.50, while the posttest is 6.77. Creating also demands higher levels of thinking from pupils to generate ideas from vague concepts to form and establish new perceptions and thoughts.

As for this study, relating to the results of the test scores, argumentation did not increase or enhance the creating skills of the pupils. This may be attributed to the need for the skills to be taught in multiple ways. Since creating requires high-level thinking, it should be improved using multiple teaching methods over a long period to improve these skills. Furthermore, due to the time of implementation of this research, the respondents might not have enough time to improve the said skills.

Table **3** Test of Differences Between the Pretest and Posttest Scores of the Respondents in Terms of STEAM Skills

STEAM Skills	t	df	Sig. (2-tailed)
Critical Thinking	-2.358	29	.025
Collaboration	-1.644	29	.111
Creativity	-2.443	29	.021
Communication	-4.094	29	.000
Problem-solving	-4.428	29	.000

Legend: Sig (2-tailed) ≤ .05 (Significant); Sig (2-tailed) ≥ .05 (Not significant)

Table 3 shows the Test of Differences Between the Pretest and Posttest Scores of the Respondents in Terms of their STEAM Skills. Firstly, the findings indicate a significant improvement in the learner's critical thinking skills based on the results of their Pretest and Posttest scores. This suggests that learning through argumentation activities encouraged the improvement of learners' skills in terms of thinking critically. The 5.43 to 6.33 increase supports this claim.

The possible reason for this significant improvement is that argumentation strategies engaged learners to actually analyze data, assess the claims of their classmates, and scrutinize the evidence presented by their teacher and other participants both in oral and writing. By logically evaluating the arguments, learners tend to enhance their critical thinking skills alongside their reasoning. This result is aligned with the study of Srinawati &Alwi (2020), underscoring the vital role of arguments in developing learners' critical thinking skills. Furthermore, when learners are given a situation that necessitates them to make arguments and claims out of it, they tend to be critical in every detail that they can use to prove their stand in a debate, role-playing, inquiry-based activities, and position papers.

Regarding collaboration, the scores also tell that the intervention did not significantly affect the respondent's collaborative skills. To interpret this result, it is crucial to note that learners already possess high collaborative skills. Hence, limiting significant improvement that can be attained. Nonetheless, several factors can be attributed to these results, first, since the implementation of this study was in the post-pandemic era when schools were starting to open again their doors, learners still refrained from working with each other. This situation might affect the scores' result in their collaboration. Pupils should follow some protocols to limit contact and prevent them from contracting the virus. Second, due to the schools' inconsistent schedules and extreme conditions such as typhoons and heat waves, the learners may have a problem collaborating with other students since most students do not have gadgets to team up with during these days. It is also important to note that collaboration is best improved when there is practical and physical interaction within the group. Unfortunately, collaboration can be challenging due to the new normal education circumstances.

Regarding creativity, learning through argumentation is effective in improving pupils' creative skills. Engaging in argumentation activities prompted learners to think outside the box to develop novel ideas to deliver and defend their standpoint regarding a topic effectively. Moreover, in rebuttal (oral or written), learners are pushed to be creative in answering questions and supporting the ideas (Fideli & Aliazas, 2022). Argument provokes pupils to explore various strategies to creatively prove a point(Henriksen et al., 2017). It fosters creativity because argumentation activities provide frameworks for learners to deviate from conventional

approaches to let other pupils understand their views and opinions.

In terms of communication, learning through argumentation was effective and significantly improved the learners' communication skills. These findings suggest that communication skills can be improved without improving collaborative skills. Although they are related, communication and collaboration are different skills. This is consistent with the study of LaFrance et al. (2019), stating that these two skills can be improved differently and need different interventions to be enhanced.

The significant improvement in the communication skills of the respondents may be due to the opportunities to communicate provided by learning through an argumentation approach where learners are prompted to compare, scrutinize, and question other points of view related to the topic at hand. Moreover, during the implementation, learners might understand the importance of communication in the class thus, giving them an intrinsic motivation to communicate well, especially during oral arguments and writing position papers.
Lastly, argumentation also fosters problem-solving skills. Through argumentation, individuals can develop problem-solving skills. By identifying and analyzing problems, evaluating evidence, proposing potential solutions, and defending them, critical thinking skills are enhanced, leading to effective solutions. Therefore, engaging in argumentative activities could enhance analytical thinking, prompting respondents to think critically about problems and providing a route to effective judgments.

Studies indicate that argumentation-based approaches have a positive impact on problem-solving abilities. For example, Hasançebiet al. (2021) research investigated how argumentation-based instruction improved students' problem-solving skills in a science education setting. The findings demonstrated a significant incre-ase in student performance after argumentation instruction was implemented. This study reveals the potential of using discussion and debate as an effective way to enhance problem-solving abilities.

Table**4**Test of Differences Between the Pretest and Posttest Scores of the Respondents in Terms of Higher Order Thinking Skills

Higher-Order Thinking Skills	t	Df	Sig. (2-tailed)
Analyzing	-4.351	29	.000
Evaluating	-3.981	29	.000
Creating	-.468	29	.643

Legend: Sig (2-tailed) ≤ .05 (Significant); Sig (2-tailed) ≥ .05 (Not significant)

Table 4 shows the test of the difference between the pretest and posttest scores of the respondents in terms of higher-order thinking skills. The data pose a significant difference result in terms of analyzing (0.000) and evaluating (0.000) while yielding not significant results for creating (0.643).

The table suggests that learning through the argumentation approach increased the learners' posttest scores from 7.93 (pretest) to 10.03, posing a significant difference between the two tests. This indicates that after the program's implementation, the respondents' ability to break down complex ideas and draw conclusions is improved. The argumentation approach allows learners to simplify complex ideas using varied activities. Furthermore, learners are exposed to scenarios that prompt them to draw conclusions based on the arguments and evidence. Thus, in turn, they developed their skills in analyzing. According to the study of Sclater et al. (2016), students tend to improve their analytical skills when they are exposed to a wide range of activities that allow them to analyze arguments and determine the underlying reasons behind phenomena critically.

On the other hand, the p-value of 0.000 reveals that argumentation significantly impacts the evaluating skills of the learners. The t-test results suggest that the improvement of evaluating skills is not likely due to chance and can be connected to the effectiveness of the intervention itself. Furthermore, the results propose that when the respondents are exposed to argumentation activities, they tend to improve their skills in assessing concepts, weighing evidence, and having the capacity to reject or accept ideas.

In engaging in debates, learners were engaged in different perspectives, comments, and viewpoints. Thus, having an opportunity to evaluate the ideas they have heard and critically assess whether they are acceptable. Osborne and Patterson (2011) underscore that argumentation activities lead to improved assessment skills where learners can demonstrate how they can effectively make informed choices, evaluate evidence, and construct arguments well, among others.

Regarding creating, the pretest (6.50) and posttest (6.77) scores suggest that learning through argumentation did not posit a significant difference between their test scores. The insignificant results may also mean that the implemented approach could not target the actual skill set of creating. Since the study targeted multiple skills to be improved, it might affect the quality of instruction for this skill, knowing that the

instruction was not specifically targeted to creating skills only. Also, creating demands skill in generating novel and authentic ideas and thinking outside the box, which requires specific instructions and assessments (Tomlinson, 2014). Moreover, this skill is a multifaceted ability requiring a comprehensive improvement approach.

Although the result did not pose significant results in creating skills, it is important to note that the specific approach and activities focused mainly on other aspects of HOTS, such as evaluating and analyzing evidence. When the respondents argue, they don't create their evidence. They just evaluate and analyze. This setup might affect the results of the study. It is also recommended that other researchers may design assessment tools that focus on the creating skills of the pupils.

IV. CONCLUSION

Based on the pretest and posttest scores of the respondents, the data revealed that all initial levels of respondents in terms of their STEAM skills are within the average category except for collaboration which is already high. After the posttest, critical thinking, collaboration, creativity, and problem-solving yielded scores that fell in the high-level category positing the effectiveness of learning through argumentation in improving those skills. Regarding HOT skills, evaluating and creating were on the average category in the pretest, while analyzing fell in the category of high level. After the intervention, analyzing learners' skillsand evaluating while creating skills remained in the average category, suggesting that arguments foster higher-order thinking skills.

Regarding the test of difference in the posttest scores in STEAM skills, critical thinking, creativity, communication, and problem-solving pose significant results. This suggests that when learners are exposed to argumentation activities such as debates, making position papers, reflection, and among others, they tend to be more critical in assessing ideas. Moreover, learners are more likely to be better communicators and problem-solvers. Argumentation also fosters creativity because respondents tend to deviate from conventional approaches for their ideas and opinions to be understood better.

Also, the pretest and posttest scores of the learners in terms of higher-order thinking skills pose a significant difference in analyzing and evaluating while yielding insignificant results in creating. This reveals that learning through argumentation can be an effective approach to enhancing the ability of learners to analyze and evaluate ideas, whether orally or in writing.

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