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EVIDENCE-BASED REASONING: EVALUATING DAILY EXPERIENCES IN THE ENGINEERING DESIGN CLASSROOM FOR MIDDLE SCHOOL STUDENTS

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ABSTRACT

Effective argumentation in science classrooms relies on the ability of students to evaluate evidence. However, there is a gap in research concerning students' capacity to validate evidence, particularly in the context of engineering design. Evidence validation skill is crucial for fostering reasoning and strengthening argumentation. This study aimed to explore students' ability to investigate evidence in engineering design classrooms, drawing from their daily life experiences. This study was framed by a qualitative approach, with a case study design involving students in a coffee farming community. The students were assigned an engineering project related to coffee preparation, based on a problem statement devised by their teachers using the Engineering Design Process. Data was collected through observation of the students' activities in the engineering classroom. Small-group discussions were held, and the data was recorded, transcribed, and analyzed using semantic gravity (SG). Our results reveal that students hailing from farming backgrounds were able to devise solutions based on their firsthand experiences in processing coffee with their families. The environment in which the students were raised plays a pivotal role in their learning. These findings underscore the importance of contextual learning in educational design. Educators should consider students' backgrounds and experiences when planning instructional strategies.

Keywords: coffee farming; evidence-based reason; EDP; students' experience

INTRODUCTION

Argumentation, a fundamental skill in education, is indispensable when exploring and discussing scientific phenomena and engineering design (NGSS, 2013). This skill involves defending claims, evaluating them, responding to counterarguments, and drawing well-founded conclusions (Drymiotou et al., 2021; Noroozi, 2022). In science education, the ability to support a claim with evidence is paramount, and students must collect empirical data through observation and experimentation to elucidate scientific concepts (Erduran et al., 2015; Guilfoyle et al., 2021). The ability to validate evidence, which plays a vital role in reasoning in argumentation, is crucial to students (Miralda-Banda et al., 2021).

Moreover, argumentation skills are not limited to science classrooms but are also applicable to engineering practices (Wilson-Lopez et al., 2020). Evidence-based decisions require engineers to collect relevant evidence to support their solutions and convince clients that the solution

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is worthwhile (Mathis et al., 2017). When developing research in an engineering context, evidence-based decisions are termed evidence-based reasoning, which occurs when students engage in argumentation with relevant evidence (Siverling et al., 2019; Holincheck et al., 2022). Engineering is described as any engagement in the systematic practice of design used to develop a solution to improve human needs (Gale et al., 2018). In engineering classrooms, students are often tasked with assuming the role of engineers to address real-world challenges by applying scientific principles to devise solutions. However, the integration of engineering education into school curricula is not ubiquitous, particularly within the Asian context where it remains relatively uncommon (Keratithamkul et al., 2020; Zhu et al., 2022).

Effective implementation in the classroom can be integrated with science, technology, engineering, and mathematics (STEM) approaches (Roehrig et al., 2022). However, there is little research on students' argumentation in the engineering context in terms of presenting evidence to support their design solutions. The need to investigate students' argumentation and evidence-based reasoning within the engineering context is underscored by a dearth of research in this area, as highlighted by Wieselmann et al. (2020). Particularly, there is limited understanding of how students present evidence to support their design solutions (Baze et al., 2023). Therefore, there is a justified call for studies aimed at measuring evidence-based reasoning in students' designs. In engineering design, the justification of design choices often draws upon a combination of experiential knowledge (Subramaniam, 2022) and cultural influences (Hecht, 2021), aligning with the Convergence Theory of Learning, which posits that knowledge construction is shaped by both internal factors, such as individual experiences, and external factors, such as cultural background (Hornstra et al., 2023).

The Convergence Theory of Learning posits that the process of knowledge construction is influenced by both internal and external factors. Internal factors encompass an individual's intellectual and spiritual potential. External factors, on the other hand, encompass an individual's environment, including parents, friends, culture, and society (Xu et al., 2020; Rezaly et al., 2021). In the context of science education, Convergence Theory is intricately linked to students' social and cultural concepts (Kidwell & Pentón, 2019). This theory suggests that students have the capacity to construct knowledge rooted in their environment, drawing from experiences at home and their cultural background (Wals et al., 2014). Moreover, it acknowledges the role of the learning process in instructional design, emphasizing the cultural emergence in engineering and scientific practices (Carberry & Baker, 2018).

In practical educational approaches, Convergence Theory is manifested through the integration of subjects, such as STEM (Sya'bandari et al., 2019). This integration extends beyond STEM-specific courses, finding applications in both STEM and non-STEM courses (Pleasants, 2020; Ortiz-Revilla et al., 2022). The practical application of STEM principles can be embedded in non-STEM subjects, such as art, economics, and policy. Additionally, STEM education has the potential to guide students toward their career goals based on their unique experiences (Wieselmann et al., 2021). These experiences serve as a bridge for students to construct new knowledge (Dinç et al., 2023).

Our study posits that students' lives and cultures can potentially be intertwined with scientific phenomena. Students can enhance their knowledge by connecting it with their values and cultural identity (Gilde & Volman, 2021). This connection enables them to design solutions rooted in their daily experiences and relate them to scientific phenomena (Carberry & Baker, 2018). Their daily experiences can serve as valuable evidence to support their proposed solutions in the face of real-world problems (Osborne et al., 2004). In the process of creating new knowledge, students engage in a cycle of concrete daily experience and reflective observation based on real-world problems. This interaction reinforces abstract concepts in their minds and culminates in the application of new knowledge in real-life situations. The process, which involves daily experiences in the building of knowledge, is referred to as the experience learning cycle, and it is one of the factors in designing solutions for problem-solving (Li & Armstrong, 2015). Through this process, students are able to arrange the scientific evidence based on their daily experiences. However, there remains a dearth of research concerning students' competency in evaluating pertinent evidence to construct coherent scientific arguments.

The Engineering Design Process (EDP) encapsulates what engineering accomplishes in the design process and its societal impacts (Johnson, 2013). This type of thinking becomes evident when individuals engage in engineering problem-solving, driven by internal motivation and reflective thinking to create innovative solutions (Avsec & Sajdera, 2019). Moreover, the EDP needs to involve daily experiences as part of developing designs to solve problems. Integrating the engineering thinking process into the classroom is a practical approach that focuses on helping students complete engineering projects and apply their knowledge and daily experiences across various subjects (Kloser et al., 2018; Yu et al., 2020). This approach enables them to solve real-world problems through STEM education. Research on the engineering thinking process primarily focuses on its impact on student achievement. For example, Mathiphatikul et al. (2019) applied the Engineering Design Process (EDP) to enhance students' creativity skills, while Isabelle et al. (2021) concentrated on improving student achievement using the EDP in their classrooms. The EDP also enhances students' skills, aligning them with the demands of the 21st century (Lin et al., 2021). Furthermore, it fosters students' argumentation skills, enabling them to explain the connections between their design solutions and scientific knowledge (Putra, et al., 2023a). However, research exploring students' abilities to gather and analyze evidence to support their argumentation in engineering classrooms remains an area that requires further investigation.

To specifically address the exploration of evidence-based reasoning among students, the case of students in coffee farming areas provides a valuable study opportunity. Students in these areas often exhibit low motivation to study science in the classroom due to their intentions to work alongside their parents on coffee farms. It's worth noting that coffee farmers in these regions typically have low incomes, often stemming from inadequate education (Hasdiansyah et al., 2021). To address this, teachers need to motivate the students by using learning approaches that provide opportunities to integrate their daily experiences, thereby supporting the resolution of real-world problems in the EDP classroom.

The assessment of evidence-based reasoning involves students demonstrating their ability to present evidence to support their designs for problem-solving. Additionally, students can enhance the quality of evidence by drawing upon their experiences in daily life that are relevant to the given problem (Miralda-Banda et al., 2021). This research focuses on evaluating the quality of evidence collected by students for designing solutions using their daily experiences, employing Semantic Gravity as the assessment tool (Wolmarans, 2015).

The aim of this research is to explore students' decision-making processes and their learning experiences in generating evidence within the engineering design process (EDP) classroom. Two research questions guided our study: (1) What is the quality of the evidence used by middle school students to support their ideas when solving a problem?; (2) How do students' daily experiences contribute to their ability to generate support for their ideas in solving problems?

METHODS

A qualitative approach was used in this study with a case study design. This design was chosen as our research focused on evaluating students facing the science phenomenon based on their experiences in the coffee plantation area (Creswell, 2012). Its emphasis on participant observation and involvement in the community allows researchers to understand the world from the perspective of the people they study, resulting in themes and patterns in the participants they observe.

For this study, coffee processing was taught to students in the middle school science classrooms, where they connected to the topic and the concept of heat transfer. Teacher arranged the program following the EDP over four weeks (Table 1) (Putra, et al. 2023b). The steps of EDP include defining a problem, learning science concepts, planning a solution, trying a solution, testing, and deciding a solution.

Table 1. Coffee Processing in a Science Classroom

Week	EDP step	Activity in EDP
1	Defining a Problem	Orientation to the problem of coffee processing
2	Learning and Planning	Learning the concept of heat transfer
		Planning a solution to the problem
3	Trying and Testing	Trying the students' proposed plans
		Testing students' solutions
4	Deciding	Decision, reflection, and comparison

This study included three students whose fathers were coffee farmers and three students without experience of coffee processing coffee (Table 2). The participants were selected by purposive sampling criteria based on the student's family background and their coffee processing experience. Meanwhile, the students without the experiences in coffee processing were selected based on the highest achievement in the science subject in that classroom. The students from coffee farming families had more experience processing coffee because they had helped their parents on their farms on a daily basis. However, they did not consider that coffee processing was related to heat transfer.

Table 2. Participant Demographics Have Been Anonymized to Ensure Confidentiality

Group	Name	Gender	Grade	Description
A	FA1	Female	8th	Coffee farmer
	MA1	Male	8th	Coffee farmer
	FA2	Female	8th	Coffee farmer
B	FB1	Female	8th	Non-coffee farmer
	MB1	Male	8th	Non-coffee farmer
	FB2	Female	8th	Non-coffee farmer

Data triangulation was applied, with the first aspect being an open-ended interview process. The open-ended interview was chosen because it allows amore in-depth information about the participants' opinions without limiting the researcher's viewpoint. The pre-interview aimed to explore the students' experiences of processing coffee and connecting them to science concepts in everyday life. The post-interview aimed to evaluate the students' concepts of heat transfer. The second aspect was the students' group discussion process when they were completing their Engineering Design Worksheets using students' activities protocol. The students were divided into two groups to solve the problems and evaluated them based on their experiences. The students' activities were recorded using a video recorder to gather data on their reasoning to support their ideas based on the collected evidence.

Before the data were analyzed, the recordings of the interview and discussion processes were transcribed verbatim into Word. The transcripts were labeled with explicit ideas for the concern and inference. The data analysis followed the Semantic Gravity (SG) approach to indicate the students' evidence levels based on their experiences with coffee processing and their science knowledge toward engineering practices (Wolmarans, 2015). The coding of SG was based on the evidence level in SG (Table 3).

Table 3. Description of Semantic Gravity (SG) Codes

Code SG level	Description of code
SG–	Evidence is weak and abstract
SG-	Evidence: Science concept abstract
SG +	Evidence explains general, everyday examples of the engineering process
SG++	Specific Evidence offers an example connected with the science phenomenon and engineering practices

The collected data were evaluated to ensure their validity and reliability. A peer review examination of the collected data was conducted as an evaluation tool in this study. All the researchers coded all the dataset, and the results were discussed to develop an interpretation level based on the SG code (Merriam & Tisdell, 2016). When there was a difference in the interpretation between researchers, a Zoom group discussion was conducted online to decide on the SG level of the students' statements.

RESULTS AND DISCUSSION

The organization of the evidence based on the SG analysis is described in Figure 1. According to the SG graph, students in Group A demonstrated a greater ability to collect evidence to support their arguments compared to students in Group B. Over the course of four weeks, students from both Groups A and B showed a gradual increase in their level of evidence discussion. By the second week, students had actively engaged in planning solutions and presenting arguments in both groups. They gathered evidence based on their experiences to substantiate their arguments.

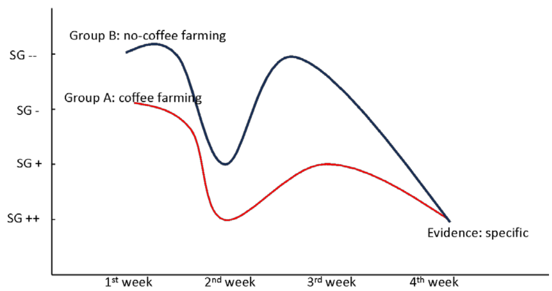

Figure 1. The Results of Students' Evidence Arrangement Based on Semantic Gravity Across the Weeks

The comparison demonstrating evidence between groups A and B has been detailed in Figure 1. The line graph illustrates that group B exhibits a lower ability to demonstrate evidence-based reasoning skills compared to group A. Group A, having more daily life experiences to support their ideas, can provide more specific evidence than group B. Additionally, initially, group B struggled to organize their evidence adequately. However, over time, through experiential activities in the engineering classroom, they were able to improve. By the fourth week, they could arrange evidence based on their experiences, such as serving coffee in the classroom.

In Group A, members were able to apply reasoning using everyday life phenomena. During Week 1, students defined the problem based on information provided by their science teachers, which is discussed in Vignette 1:

Group A

FA1: "This problem emphasizes that the local society in the area is not interested in consuming coffee from this region."

MA1: "[yea…] The coffee processing is not adequate. Perhaps it needs to be roasted more at a sufficient temperature." (SG-)

While students in Group A explained the evidence in detail, the level remained SG--. MA1 explained the problem, including coffee processing, drawing on his experience to note that the coffee's taste was inadequate due to the roasting time and temperature of the coffee beans. Although MA1 mentioned the relevance of temperature, the concept remained somewhat abstract since he did not specify the required temperature or roasting time. In contrast, FB2 explained her statement at the SG-- level. She discussed the problem, but her reasoning was not based on the given problem. Vignette 2 describes the conversation between students in Group B:

Group B

FB1: (*writing the answer*) "What is the problem?"

FB2: "Recently, coffee sellers have [had] difficulty selling the coffee." (SG--)

By the last meeting in the EDP classroom, the students had gained the necessary skills to consider how to present evidence to support their ideas. When making a decision in the EDP, the students reflected on their efforts to evaluate their ideas. They collected evidence to redesign the best product based on their experiments. Specifically, group A mentioned that their life experiences have supported their idea. The students demonstrated the best evaluation skills during Week 4 regarding a design for processing coffee. Based on the SG graph, Groups A and B reached the SG++ level at the end of this project. The following statement is an example of students presenting evidence in the decision step (Week 4, Vignette 3).

Group A

MA 1: "What is our decision?"

FA1: "I have had the experience of using different pans to roast the coffee beans."

FA1: "Based on the table of heat capacitance, we can choose the material with the lowest heat capacity to expedite the roasting process. In my experience, we should choose that one to save energy and time during processing. The customer wants thier coffee served as soon as possible" (SG++)

MA1: "So what is the best material? How [about] if we choose aluminum because my father usually uses it. If we compare aluminum, zinc, and copper, aluminum is the best one." (SG++)

Group B

FB1: "This coffee has a good aroma. This is (Robusta)." [FB1 smells the coffee beans].

FB2: "When the coffee is brewed, the hot water must be 100°C. This situation [is] to anticipate that the coffee powder mixes with water. I tried [it with] the water below 100°C in this experiment, [and] I saw [that] the coffee powder didn't mix perfectly." (SG++)

MB 1: "We decided that we will serve the coffee and should control the water temperature quality. [It] must be confirmed that the water [is] 100 °C , because in our area, water will boil [at] 100 °C." (SG++)

Vignette 4 describes how students in each group built their knowledge. Group A referred to their family's behaviors, while Group B discussed their experiences in the classroom activities. Figure 2 illustrates how these groups developed their knowledge. This figure provides a visual representation of how students in both groups developed their understanding of scientific concepts and their ability to use evidence effectively throughout the course of the study. It highlights the progressive growth of their knowledge and the application of this knowledge to practical, real-world scenarios.

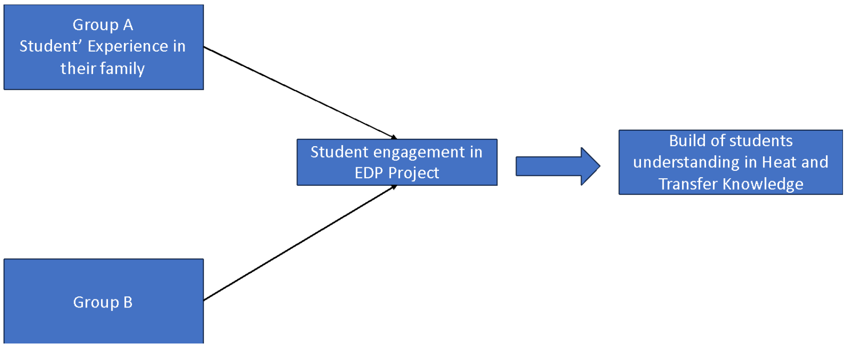

Figure 2. The Concept of Building New Knowledge between Students in Group A and Group B

Supporting data were also seen when students answered the pre- and post-review questions.
MA1: "My father is a coffee farmer. Furthermore, my family also processes coffee beans in our home. I have [an] aluminum pan for roasting the coffee manually. I help [my father] frequently. However, I don't know the concept of physics for the coffee processing that I have done." (pre-interview)
MA1: "I learnt that coffee processing needs the concept of physics. I understood the temperature [needed] when I boil the water to serve the coffee. I learnt about the material [needed] to match with the coffee." (post-interview)

In contrast, Group B students had no coffee processing experience:
MB1: "I don't have any experience of processing coffee, but I have observed my neighbor processing coffee. He uses a frying pan, spatula, and coffee beans." (pre-interview)
MB1: "I learned [the] concept of science in this project. When I was boiling the water, I knew that [the] concept was [a] convection current." (post-interview)

These examples show that in Group A, the students explained the evidence from their experiment in the project and connected it to their experience of processing coffee. In the pre-interview, MA1 had no understanding of the relationship between coffee processing and scientific concepts. However, after learning in the EDP classroom, MA1 connected the science concept with his daily life experiences. The development of knowledge in MB1 showed that he acquired knowledge about heat transfer solely through his experiment in the EDP project. Another example was FA2, who discussed her understanding of serving coffee:
FA2: "One factor influencing coffee's taste is the water's temperature used for brewing. I observed that when the water wasn't hot enough, the coffee didn't mix perfectly, based on my parents' actions." (pre-interview)
FA2: "The water used to mix the coffee is critical for serving. The temperature of the water can be increased based on the water's mass and pot material. In this design, I used two materials to boil the water: zinc and aluminum." (post-interview)

FA2 elaborated on the process of mixing coffee, drawing upon her experience at home when her family served coffee. After completing lessons in the EDP classroom, she was able to provide a detailed explanation of how to boil water effectively for coffee serving. This highlighted how personal experience reinforced new knowledge. Students in Group B did not have any experience of serving coffee with their families but acquired this knowledge through the EDP classroom. In the pre-interview questions, students' responses were based on hypotheses about scientific phenomena.

The students became more involved in their surrounding environment to build their ideas for solving the problem. Group A showed that the topic was relevant to their home experiences. Students already have intuition and preconceived notions about applying scientific developments in their daily life as a result of this experience. They used a methodology to solve the problem based on their observations, the experiment, and discussions with their parents. This approach follows the theory of science freedom (Miller, 2001), which states that students should be allowed to understand a science phenomenon by expressing their ideas as scientists and engineers do to generate new ideas. Students are able to explore their previous knowledge to collect the evidence in building arguments. This finding is consistent with previous research highlighting the significant role of students' prior knowledge in the construction of argumentation in science (Baytelman et al., 2020).

In this research, the students generated a claim regarding a solution and organized their evidence to support the claim. During Week 1, the students demonstrated a low ability to gather evidence to support their claims. They collected information from the problem letter to understand the problem, the user requests, and the constraints. The students were able to understand the science concept, as they regularly connected situations with science, and they felt that this subject was science. The students also focused on the design in terms of engineering and the specifications, constraints, and goals. This situation shows that students can shift their ability from only considering science to including engineering in solving problems. Previous research has elucidated that problems connected to real-life situations prompt students to utilize science and engineering concepts in their problem-solving approaches (Drymiotou et al., 2021). This behavior is identified as a characteristic of engineering design (Johnson, 2013; Sharunova et al., 2022).

Our findings shed light on the key aspects of engineering design exhibited by students. We observed that students actively express their opinions within their designs to tackle problems, demonstrating a thoughtful evaluation process rooted in their daily experiences. Additionally, students demonstrate a commitment to refining their designs to enhance problem-solving effectiveness. These findings support previous research indicating that the engineering classroom fosters an environment where students can improve their problem-solving abilities by engaging with real-world scenarios (Dasgupta et al., 2021; Boettcher et al., 2023).

The students in Group A implemented an engineering design based on their experience of processing coffee with their families. MA1 considered the problem and related it to his experience. Furthermore, he connected this with science when considering temperature. He emphasized this phenomenon in his real-life environment and his family's condition. This situation showed that students could improve their ability to think about science based on their environment (Akbayrak & Namdar, 2019). Vignette 1 describes how the students gained the ability to support evidence based on their experiences and environments. FB1 had no experience of serving coffee prior to class. She read and answered the problem based on the problem letter. She had not yet collected evidence and connected it with science phenomena. This activity aimed to improve the students' focus on defining the problem and asking questions as the first stage in the EDP classroom (see Table 1) (NGSS, 2013). The aim of the first step was that the students could define the problem given. In this step, group A successfully linked their daily experiences with the problems presented in the classroom. Our findings also highlight the diverse ways in which students develop their ability to select evidence, reflecting the influence of their personal experiences on knowledge acquisition. This observation is supported by Groth et al. (2020) research, which emphasizes on how students' everyday experiences significantly shape their understanding of scientific concepts.

In the second step, students engaged in learning and designing to develop solutions. Within this phase, students in group A integrated the problem with scientific phenomena, particularly focusing on understanding physics concepts related to heat and transfer. Drawing upon their everyday experiences, such as assisting their families in processing coffee, they applied this knowledge to devise improved methods for serving coffee. During the trial phase, students compared various equipment for coffee service, and in the decision-making step, they were able to evaluate which materials would best serve the coffee.

The student's ability to collect evidence in the EDP classroom showed improvement throughout the study. However, the students' knowledge in Groups A and B increased differently (see Figure 2). Group A was already familiar with and connected with the topic based on their everyday lives. Furthermore, the students enriched their knowledge of physics concepts, mainly heat transfer, via an experiment performed in the classroom. They were able to connect how to produce good-quality coffee with a science concept and their families' experiences (Xu et al., 2020). This result aligns with research conducted by Rezaly et al. (2021) who found that students' experiences could be a tool to filter which students can select evidence to build their claims and organize their arguments. In Group B, the students discussed and developed ideas based on the EDP classroom. During Week 4, FB2 stated that she tried to boil water to mix coffee powder when she experimented in the EDP classroom. Her evidence showed that the coffee needed to be boiled at 100^{o} C. She described the phenomenon as a science concept without mentioning engineering performance. Additionally, she connected her experience of learning science to improving her knowledge of heat transfer. It was found that FB2 hadless experience in engineering processes related to the selected topic, specifically heat transfer. This situation describes that students focus on science as related to the topic in the classroom and then look for the opportunity to explore engineering as the context of student life (Wieselmann et al., 2020).

When teachers develop instructional design, they must consider students' conditions, including prior knowledge, experience, culture, and social conditions. This study demonstrates that when a teacher selects a topic related to a student's life, it reinforces students' understanding of engineering design thinking and science concepts. These findings are consistent with previous research indicating that authentic experiences enhance students' ability to evaluate evidence and develop fundamental concepts by engaging in the process of designing a product (Wu et al., 2021). MA1 described a shift in knowledge regarding the science concept between the pre- and post-interviews. He explained the engineering concept when he mentioned a tool that was utilized when helping his parents process coffee beans. However, in the pre-interview, he did not realize that he was also implementing a science concept. He could explain the engineering design because he had an experience in that area, and this experience influenced his thinking in terms of a design for processing coffee. This finding aligns with previous research, which suggests that the longer students grapple with a particular problem, the more adept they become at addressing it (Rodríguez-Chueca et al., 2020). These results also underscore the experiential learning cycle, which posits that knowledge is constructed through students' experiences, encompassing observation, practical engagement, and reflective thinking (Li & Armstrong, 2015).

After the students followed the EDP in the classroom to solve the problem, they understood the science concept. MA1 related this to his home situation, noting that the material of the pan used for processing coffee affected the time required to boil the water. The students learned about heat capacity in this situation. MA1 made a claim based on the engineering process experience and presented evidence based on the experiment using the science concept. This research confirmed that science concepts can be explored to collect relevant evidence to support an idea and solve a problem in EDP classrooms (Farrell et al., 2019). Moreover, the students' experience in engineering design is a valuable asset for enhancing their scientific skills as a *ligne* with the previous research by Klofutar et al. (2022).

This research was conducted in a specific community whose members are familiar with traditional coffee processing. Educators should plan students' classroom activities based on the students' environments. This strategy allows students to connect with their real-life experiences and implement what they learn in the classroom in their environment. The choice of the topic in this research exemplifies how students can formulate solutions based on their immediate environment, further validating the idea that hands-on, context-specific learning experiences can be highly effective (Membrillo-Hernández et al., 2019). Additionally, the utilization of the EDP in this study promotes integrated learning across subjects, allowing students to grasp not only isolated subject matter but also multiple subjects simultaneously (Roehrig et al., 2021). The instructional design of EDP can serve as a valuable model for schools lacking a curriculum in engineering subjects such as in the Asian context that gave the alignment of results (Wahono et al., 2020; Sulaeman et al., 2022).

A limitation of this research is the relatively modest number of participants and the specific focus on a particular community. Future research endeavors should aim to encompass a more extensive and diverse participant sample, including individuals from various cultural backgrounds and contexts to enhance the generalizability of the findings. This research is specific to a particular society, culture, and geographic region, which may limit its applicability to more diverse educational settings. Nevertheless, it underscores the significance of aligning learning strategies with students' lives, a principle that holds promise for improving the understanding of science concepts across a variety of contexts. While the study illustrates how classroom activities can be implemented in students' lives, further investigation into the extent to which these implementations occur and their long-term impact would provide a more comprehensive understanding of the practical implications.

CONCLUSION

This study investigated students' ability to collect evidence and solve real-world problems given to them by their teachers. The students drew upon their environments and experiences to produce solutions. Based on the SG analysis, Group A (the student farmer group) had a greater understanding of the problem and topic, which aided them in designing a solution, than Group B (the non-farming students) did. The results revealed a gradual improvement in the ability of both groups to provide quality evidence in support of their ideas.

This result stemmed from Group A students connecting their daily-life experiences with their families to the problem. The students' daily experiences played an essential role in improving their understanding of design in the EDP classroom. Students in group A integrated their daily experiences from serving coffee in their families and connected them with scientific concepts.

Therefore, this finding supports contextual learning when educators organize their instructional designs. Specifically for engineering classrooms, more development of lesson plans and projects with real-world problems is needed.

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