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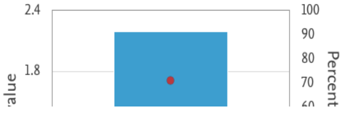

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Gender roles in engineering design process activity: A small group exploration through collaborative argumentation

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Abstract

Gender plays a crucial role in science and engineering education. This study aims to explore gender's role in an engineering design process (EDP) classroom, particularly in relation to argumentation skills. This qualitative research used a case study and focused on student behavior contributions to argumentation skills, separated by gender. The participants included 12 students (6 male and 6 female) in 8th grade who participated in a collaborative group problem-solving exercise. All activities of students in the EDP classroom were recorded and transcribed to be coded using code-driven argumentation theory (claim, data/evidence, and reasoning). According to the results, the male students were more active in constructing reasoning in argumentation skills than the female students. Additionally, the female students actively claimed scientific phenomena and communicated during the discussion stage.

Introduction

In the twenty-first century, scientific argumentation has become a skill whereby students need to conceptualize the core ideas about science. The Next Generation Science Standard (NGSS) also mentions that argumentation has become one of the engineering and scientific practices used to advance scientific thinking (NGSS, 2013). Argumentation is required to build the concept of science based on the accuracy of the evidence (Erduran et al., 2015). In addition, argumentation involves the skill of critically evaluating a claim and the reasons given to support it (Iordanou, 2022).

Argumentation can be described as a discourse in which knowledge claims are individually and collaboratively constructed and evaluated, given empirical or theoretical evidence (Erduran et al., 2015). In other words, argumentation validates the explanation of scientific phenomena between claims and evidence (Murphy et al., 2018). Research on argumentation has been conducted for science teachers and students. For example, Rapanta (2021) found that teaching methods to train students' argumentation are effective pedagogical tools. Another study showed that students' experience in selecting accurate evidence can boost their argumentation skills (Gülen & Yaman, 2019).

However, the implementation of argumentation in science classrooms is challenging. For example, if the teacher focuses only on organizing the classroom for the implementation of argumentation, students are less likely to understand the scientific concept (Diniya et al., 2021). Teachers should maintain a balance between the lesson plan in argumentation and the science concept delivered to students in the classroom (Putra, et al., 2021). Murphy et al. (2018) stated that many abstractions performed to evaluate students' argumentation in a classroom begin with introducing an evaluation model, revising the model, experimenting with the students, and observing. Furthermore, topic selection is difficult for teachers who apply argumentation in science classrooms (Guilfoyle et al., 2021). One learning approach that can facilitate argumentation skills is the engineering design process (EDP).

The EDP is a learning approach that provides students with the opportunity to develop an argument to solve a problem in a real-world context. The problem can be selected from relevant issues, sociocultural factors, or student experiences (Guilfoyle et al., 2021; Songsil et al., 2019). Moreover, activities in the EDP stages involve defining, planning, learning, designing, trying, testing, and deciding (Putra, et al., 2021; Sulaeman et al., 2021). These activities allow students to collect accurate data to support their claims for solving a given problem.

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Previous research has investigated the relation between gender differences and students' argumentation skills in science and mathematics (Kalender et al., 2019; Legewie & DiPrete, 2014; Steegh et al., 2019). Moreover, Gillies (2019) organized, in small groups, the implementation of argumentation skills in a classroom. Through collaboration, students develop interdependence among group members when they complete a task. They develop their understanding by discussing the relevant task, debating about the subject content, and clarifying the information with each other. Collaboration in a classroom is intensified when the students solve the classroom task together. Students participate more actively in the learning process in a collaborative classroom than in a non-collaborative classroom. In contrast, when a task is designed for individual students, the students focus more on the argumentation test than on the learning process. This study emphasizes the roles of female and male students in arguing in an EDP classroom to solve a problem. It aims to explore the role of female and male students in an EDP classroom in building argumentation skills through collaborative argumentation. The following are the research questions that guide this study:

1. If at all, how does gender relate to argumentation skills, including claims, evidence, and reasoning, in an EDP classroom?
2. How do students construct their argumentation skills to solve a problem in an EDP classroom based on gender roles?

Literature Review

Constructivist learning theory is essential to the idea of argumentation. Science is changing and adapting rapidly and is expected to produce new knowledge (Abell & Lederman, 2010). This knowledge needs to be supported with new evidence. The communication between the valid proof and the claim of knowledge involves argumentation skills. Students need to assess their argumentation skills to understand the science content, because they also need to consider the science content relevant to solving a real-world problem in a science classroom (Erduran et al., 2015; Jeong et al., 2020; Osborne et al., 2004).

Students' argumentation has been evaluated for many years to describe students' argumentation skills. For instance, some researchers have adopted Toulmin's argumentation model, which involves elements of argumentation: claims, reasoning/warrants, data/evidence, and backing/supportive argumentation (Toulmin, 1958). Gülen & Yaman (2019) found that implementing the Toulmin model in a science classroom can improve students' performance. However, students' classroom performance is not adequate for observation. Lin and Mintzes (2010) explored students' argumentation skills by adding an element to the Toulmin model using counter-argumentation. This element drives students to reflect on their argumentation skills based on scientific problems. This model has mainly been used to evaluate students' argumentation skills through writing so that students can carefully examine their reasoning (Songsil et al., 2019). The implementation of argumentation skills in a science classroom has recently covered claims, reasoning, and data/evidence (Sampson et al., 2020). The reasoning skills links between claim and evidence, and this model can be used to observe students' argumentation quality when they talk in group discussions (Mathis et al., 2016; Murphy et al., 2018).

However, the quality talk in science for students to build verbal argumentation in science classrooms lacks investigation. Through verbal argumentation, students can construct an increasingly sophisticated argument and improve their arguments in the disciplinary context of the scientific problem (Murphy et al., 2018). The quality of scientific argumentation can be observed through group discussions, as the individual is for the argument based on data and the evaluation of the relevant data to support the claim (Capkinoglu et al., 2020). However, teachers still face a challenge in designing argumentation practices in the classroom through group discussions. They need to develop effective classroom discussions focusing on science-based engineering practices to deliver science content and students' activities (Aranda et al., 2020). The EDP offers a teaching approach that provides students with an opportunity to collaborate to solve a given problem. Students communicate with each other to establish a durable design and evaluate it by using relevant data and scientific explanations (Putra, et al., 2021). Moreover, students can take on appropriate roles and contribute to working collaboratively (Wieselmann et al., 2019).

Researchers have analyzed female and male students' performances in science and engineering. The results show that these performances have obtained different results. First, the results show that female students perform lower than male students in science and engineering classrooms. Fredricks et al. (2018) reported that female students are more likely to get frustrated and give up in engineering design when the material is challenging. In contrast, male students are perceived as more competent in persistence and deep strategy learning to solve problems in engineering design. Evidence also shows that, in a science classroom, female students receive less attention than males in preparing the data to construct argumentation (Oon et al., 2020). Argumentation research has also compared male and female student teams formed to solve engineering problems. The results indicate that the male team pays closer attention to developing the argumentation structure than the female team (Hsu et al., 2018). Second, other research on science and related subjects has shown no significant gender gap in students' achievement, especially in undergraduate students (Cimpian et al., 2020). For middle-school students, the results obtained vary depending on the class of students. For example, females have high interest in science in grade 4, while males have high creativity in grade 8.

The gender gap in science and engineering classrooms also appears in Indonesia, especially on Java Island. Mutakinati et al. (2018) investigated the motivation of middle-school students toward science and engineering careers. The results showed that female students were less motivated to pursue a career in the engineering field. Other researchers have also indicated that female middle-school students on Java Island are slightly less interested in engineering jobs (Shin et al., 2018). In particular, females hold stereotypes that they are marginalized in engineering jobs (Pirus & Nurahmawati, 2020). They tend to take care of their families, including their children (Kurniawan et al., 2018). In other words, the Javanese culture represents that women/wives are positioned under men/husbands (Prasetiyo, 2018). This study explored how gender roles contribute to the collaborative group discussion to develop argumentation rather than comparing genders. An EDP classroom was applied to facilitate students' argumentation skills through cross-gender group discussions involving male and female students.

Methodology

This study used qualitative methods, specifically a single-case method, to develop an engineering design project. The single case study focused on female and male behaviors to understand how the students participated in collaborative group discussions to develop argumentation skills (Yin, 2018).

The engineering phenomenon in the EDP classroom was related to a real-world problem on the specific topic of "heat transfer." Students were given a letter problem and asked to solve it through a group discussion in a cross-gender group. The problem is defined as follows: A village has limited electricity resources, but the people in that area should store the food longer and have good-quality food. The challenge of EDP treatment, as written in the letter, was that the students should design a solution based on the requested criteria and some constraints. The schedule in the EDP classroom is described in Table 1.

Table 1 EDP activities in the research classroom

EDP Process	Day	Student task
Problem Scooping	1st	Students analyze the engineering work.
Define	2nd	Students analyze the problem letter, write the user needs, and constrain the requested design.
Plan	2nd	Students work individually to design a solution to the problem statement and write it on the student worksheet.
Learn	3rd	Students evaluate the suitable science concepts based on their individual designs.
Design	4th	Students work in their groups to evaluate their design and discuss the best design to solve the problem by collecting evidence.
Try	4th	Students in their groups try their design and analyze the strengths and weaknesses of their design.
Test and Decide	5th	Students test their group design by presenting it to other groups and simulating their design to solve the problem.

Participants

In this study, 12 junior middle-school students (six male and six female) participated in the EDP classroom. All participants were in grade 8 in a public school in one of the provinces in East Java. Each group comprised two male and two female students. The participants' demographics are described in Table 2.

Table 2 Participants' demography in the EDP classroom

Character	*n*	% of Participants
Grade 8	12	100
Gender		
Male	6	50
Female	6	50

Data Collection

The data collection began when a teacher introduced the EDP to the students and explained the problem letter to them. Data were collected within five days of the students joining the EDP classroom (Table 1). The discussion was recorded both visually and in audio. The recording, which was transcribed and coded, became the data for extracting the science and engineering statements. To assess the credibility of the data, the authors also evaluated the EDP students' worksheets and interviewed them on the last day of the EDP class. Each interview lasted approximately 20–30 min. in accordance with the open-ended interview protocol (see Appendix).

Data Analysis

Two codes were developed to analyze the students' transcription: A theory-driven code, which focused on the discussions that the students conducted when solving the problem in small groups, and a data-driven code, which focused on the students' individual interviews about the experience of being involved in a collaboration group.

The theory-driven code was analyzed using argumentation indicators, with three indicators covering claims, evidence, and reasoning. The code for the collaborative argumentation is described in Table 3.

The data-driven code was utilized for analyzing the interview data of each student. It focused on analyzing how students constructed their argumentation skills to solve the given problem. This code is described in Table 4.

All authors observed the EDP followed by the students, transcribed, and coded the interview data of each student based on the codebook. Next, they conducted a group discussion to develop a justification for gender roles in the EDP classroom and students' construction of argumentation. Atlas. Ti was used as the software to assist in organizing the students' statements.

Results

This study described and analyzed student engagement in developing argumentation, particularly the performance of female and male engineering and science students, in solving engineering problems. Figure 1 describes the students' performance in solving the problem design and the effectiveness of the design through collaborative group discussions.

According to Figure 1, the students were generally more able to express their claims by explaining scientific phenomena rather than revealing the reasons why the existing phenomena occurred. The students had no adequate skills to scientifically explain how the evidence supported their claims. In addition, they often made claims based on their opinions without referring to data or evidence. As a result, the students could not explain why they selected the claim to solve the given problem. Male students were more dominant in the discussion and showed a greater variety of argumentation than female students.

Vignette (1) shows an example in which the students shared equipment to store food. In this episode, female students initiated the discussion and expressed their claims without supporting reasoning and adequate evidence. In this vignette, the example of the discussion process was initially worded in [P] for female students and in [L] for male students. A male student added evidence to support his claim

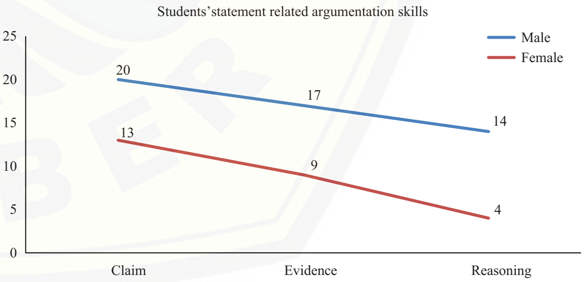

Figure 1 Comparison of argumentation skills of male and female students in the EDP classroom

Table 3 Theory-driven code used in this study

Code	Description
Claim	An opinion, result, or explanation proposed in solving a given problem
Evidence	Data or observations used to support claims
Reasoning	Reason for deciding that the support (data) is very important in proving the claim

Table 4 Data-driven code used in this study

Code	Description
Experience	Students' answers are related to their daily life experiences
Constraint	Students refer to the given problem letter and emphasize the constraint in the letter.
Science Concept	Students explain the scientific concept to be used to solve the problem.
Engineering	Students think of a prototype design to solve the problem.
Budget	Students refer the budget given or standard to create the prototype.

using scientific reasoning skills—the male student L1-1 connected the claim, evidence, and reasoning for expressing his argumentation skills. Vignette (1) shows the discussion of group 1 when trying to solve the problem. The members of this group involved [P1–1], [P2–1], [L1–1], and [L2–1].

Vignette (1)

[P1–1]: Based on this latter problem, hmm…[thinking] in my opinion, I would make pottery.

[P2–1]: Okay, I agree with you. The concepts for this problem are heat and temperature, right?

[L1–1]: hmm…[thinking for 32 seconds], How is it about heat transfer?

[P1–1]: Why is it the concept of heat transfer?

[L1–1]: Based on our experiment, pottery is able to hold the temperature inside. So, we need two pottery containers of different sizes: the smaller one inside the bigger one to store the food. This concept is related to heat transfer. (L1–1 explains and shows their design.)

[L2–1]: It's true that heat can't penetrate pottery or pottery can withstand that temperature (Gives reinforcement). Then the other size pottery container is made to contain the sand and its contents, such as food and drink." (Give opinion. See figure 2 to described the student's design)

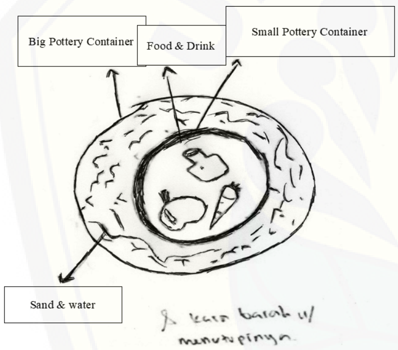

Figure 2 The student's design

In another episode, the students collected the data, but the data could not support their reasoning. Vignette (2) shows the discussion process in group 2. The students collected evidence based on a story to solve the problem. In this discussion, the female students directed the male students to stay focused on the constraints of the problem. The members of group 2 involved [P1–2], [P2–2], [L1–2], and [L2–2].

Vignette 2

[P1–2]: So... what do we need to solve the problem?

[L1–2]: Solar cells to collect energy.

[L2–2]: I need to think about it; wait in a minute [thinking for 23 seconds]. The problem is the limitation of electricity based on the story.

[P1–2]: The problem is that people in the village complain that they cannot store fruit and vegetables longer, such as when they are put in the refrigerator, and have difficulty getting cold water during extreme weather. (Give an opinion according to the phenomenon that occurs.)

[L1–2]: I agree with you!

[L2–2]: Yes, it is true. Next, what is needed to solve the problem?

[L1–2]: We need a portable refrigerator because the refrigerator could keep the food longer and keep the food in good condition.

[P1–2]: How does it work? (no one answered the problem given)

In group 3, the students also developed their collaboration skills to solve the problem. The discussion process is described in vignette 3. In this episode, the male students expressed their opinions more about engineering to solve the problem. They designed a tool that can store food effectively. Group 3 consisted of students [P1–3], [P2–3], [L1–3], and [L2–3].

Vignette 3

[P1–3]: We need a material that can withstand heat from the outside, right?

[L2–3]: How do we design a two sizes wooden block?

[L1–3]: That's right, we place the wet cloth between the two blocks as a barrier to heat generation from the outside.

[P2–3]: Could you explain how it works?

[L1–3]: The heat transfer from outside will be blocked by the wet cloth and the food and drink in the inside can stay fresh.

In constructing the argumentation, the students involved some aspects in attempting their reasoning (Table 3). In the interview process, the authors deeply explored how the students understood their group design to solve the problem. The students explained the design based on their experiences, constraints, budget, and scientific concepts. The frequency of the students' statements when they were interviewed is described in Table 5.

The interview data showed that female students were not sufficiently interested in engineering-related activities. [P1–2] stated that she preferred to solve the theoretical part of the science problem rather than the engineering design. She was also keen to read the science book but lacked the ability to perform experiments in the science laboratory. [P2–1] enjoyed studying literature because she could express her art through writing activities. [P2–1] explained that her opting for arts is related to Javanese culture, where women should be softer than men, including how to communicate. The male statements contrasted with the female statements. [L1–1] stated that the design of the problem solution was a challenge for him. He preferred to perform experiments to collect evidence in the science classroom.

Discussion

This study aimed to focus on the construction of students' argumentation skills in an EDP classroom through collaborative groups based on gender roles. The male and female students were assigned in small groups to express their roles in collaborative

Table 5 Students' argumentation construction in the EDP class

Aspect to Construct Argumentation	Male	Female	Example
Experience	4	2	"Pottery is more effective because the materials used are easy to obtain and, based on experience, can be easily used."
Constraint	1	4	"That area requires a refrigerator that does not use electrical energy directly. Maybe the people there should make more use of the resources there."
Science concept	5	3	"This pottery is not easily penetrated by heat; therefore, we review the concept of heat transfer."
Engineering	3	1	"That's the shape of the pottery; it should be conical so that it cools quickly. As a result, we have a slight decrease in temperature."
Budget	0	1	"We should consider the budget. It would be good if the cost could be decreased."

argumentation. In general, male students had more of an opportunity to show argumentation than female students in the classroom. This result is in line with that obtained by previous research showing that male students pay more attention to engineering and science tasks than female students in EDP classrooms (Nagdi & Roehrig, 2020; Oon et al., 2020; Wieselmann et al., 2019). Female students' lack of interest in mathematics and science explains why they are less keen than males to participate in engineering tasks (Steegh et al., 2019). This situation is also related to the social culture on Java Island, where females show a soft attitude (Pirus & Nurahmawati, 2020). From the Javanese perspective, the female will take care of her family, including praying for her husband and kids to be successful (Kurniawan et al., 2018).

In vignettes: (1) and (2), the female students initiated the discussion by communicating their claims in their respective groups. They frequently claimed about phenomena using scientific concepts but lacked the skills to express their reason why the claim was raised with support from the relevant collected data. This result indicates that female students were more engaged in the science task at the beginning; however, their motivation gradually decreased, mainly in engineering tasks (Fredricks et al., 2018). Moreover, the female students paid more attention to planning to keep the focus on the topic in constructing their argumentation skills by verifying the constraints in the problem letter. This result also supports previous research showing that female students tend to plan and communicate collaborative argumentation skills (Hsu et al., 2018).

The collaborative argumentation between male and female students was a good structure for solving the problem in the EDP classroom. The students supported each other based on their behavioral roles. Female students gave an idea of science concepts at the beginning, although the concepts were not adequate for explaining scientific phenomena properly. This study showed that the female students started communicating more in the discussion stage. Otherwise, the males better understood the connection between reason and the selected data to explain the claim. Male students focus on the concept of science and engineering based on the female students' claims (Oon et al., 2020; Wieselmann et al., 2019).

When some students discover a claim in the beginning, it forms the basis for the other students to establish good reasoning to solve the given problem. In other words, collaboration based on student roles reveals that students use previous peers' answers as complementary knowledge (Noroozi & Hatami, 2019). Female students dominate collaborative argumentation in support of building qualitative argumentation. They remind the group to review the constraints repeatedly to ensure that the group design is appropriate for the user.

This research also showed that the students related their experiences with science concepts more when constructing their argumentation skills. This study reinforced the need for a real-world problem to be brought into the context of a science lesson so that students use their experiences to solve their daily problems (Putra, et al., 2021). Students' experiences can guide them to take alternating roles in solving a problem in the EDP classroom to build argumentation (Gülen & Yaman, 2019). Table 2 shows that the students' experiences were valuable in constructing their argumentation. In vignette (2), the students used science concepts to develop their argumentation in the classroom. The students analyzed the letter and connected it with the science concept to make a decision to solve the problem. Content analysis in argumentation is a point for developing reasoning to support a student's claim (Dönmez et al., 2021). In an EDP classroom, students should understand the need of the end user to solve the problem, so that, in the construction of the argumentation skills, the female students pay attention to the constraints of a contract among the claim, evidence, and constraints (Putra, et al., 2021; Sulaeman et al., 2021).

Conclusion and Recommendations

Our study showed that, through the EDP, classrooms facilitate students' development of argumentation skills through small-group discussions. Thorough collaboration between female and male students provides each student with an opportunity to contribute to explaining scientific phenomena through argumentation. Based on our analysis of the argumentation gender gap, we contribute to the role of female and male students in building argumentation rather than merely justifying the poor performance of female and male students in science and engineering. The study results indicate that when teachers or researchers implement science or engineering classroom activities, they should notice the gender role and how they group students to work in collaboration. The EDP activity appreciates the smallest individual contribution in a science or engineering classroom. Teachers can implement the EDP in the classroom so that students are active in discussing and working together, especially in science subjects.

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Conflict of Interest

The authors declare that there is no conflict of interest.

Reference

Abell, S. K., & Lederman, N. G. (2010). *Handbook of research on science education*. Routledge.

Aranda, M. L., Lie, R., Selcen Guzey, S., Makarsu, M., Johnston, A., & Moore, T. J. (2020). Examining teacher talk in an engineering design-based science curricular unit. *Research in Science Education*, *50*(2), 469–487. https://doi.org/10.1007/s11165-018-9697-8

Capkinoglu, E., Yilmaz, S., & Leblebicioglu, G. (2020). Quality of argumentation by seventh-graders in local socioscientific issues. *Journal of Research in Science Teaching*, *57*(6), 827–855. https://doi.org/10.1002/tea.21609

Cimpian, J. R., Kim, T. H., & Mcdermott, Z. T. (2020). Understanding persistent gender gaps in STEM Does achievement matter differently for men and women? *Science*, *368*(6497), 1317–1319. https://www.science.org/doi/abs/10.1126/science.aba7377

Diniya, D., Ilhami, A., Dian Permana P, N., Mahartika, I., & Prakash, O. (2021). Kemampuan Argumentasi Ilmiah Calon Guru IPA melalui Pendekatan MIKiR selama Pandemi Covid-19 [Scientific Argumentation Ability of Prospective Science Teachers through the MIKiR Approach during the Covid-19 Pandemic]. *Journal of Natural Science and Integration*, *4*(1), 141–148. https://ejournal.uin-suska.ac.id/index.php/JNSI/article/view/12770

Dönmez, İ., Gülen, S., & Ayaz, M. (2021). Impact of Argumentation-Based STEM Activities on Ongoing STEM Motivation. *Journal for STEM Education Research*, *5*(3), 78–101. https://doi.org/10.1007/s41979–021–00062–2

Erduran, S., Ozdem, Y., & Park, J. Y. (2015). Research trends on argumentation in science education: A journal content analysis from 1998–2014. *International Journal of STEM Education*, *2*(1). https://doi.org/10.1186/s40594-015-0020-1

Fredricks, J. A., Hofkens, T., Wang, M. te, Mortenson, E., & Scott, P. (2018). Supporting girls' and boys' engagement in math and science learning: A mixed methods study. *Journal of Research in Science Teaching*, *55*(2), 271–298. https://doi.org/10.1002/tea.21419

Gillies, R. M. (2019). Promoting academically productive student dialogue during collaborative learning. *International Journal of Educational Research*, *97*, 200–209. https://doi.org/10.1016/j.ijer.2017.07.014

Guilfoyle, L., Erduran, S., & Park, W. (2021). An investigation into secondary teachers' views of argumentation in science and religious education. *Journal of Beliefs and Values*, *42*(2), 190–204. https://doi.org/10.1080/13617672.2020.1805925

Gülen, S., & Yaman, S. (2019). The Effect of Integration of STEM disciplines into Toulmin's Argumentation Model on students' academic achievement, reflective thinking, and psychomotor skills. *Journal of Turkish Science Education*, *16*(2), 216–230. https://doi.org/10.12973/tused.10276a

Hsu, P. S., van Dyke, M., Smith, T. J., & Looi, C. K. (2018). Argue like a scientist with technology: The effect of within-gender versus cross-gender team argumentation on science knowledge and argumentation skills among middle-level students. *Educational Technology Research and Development*, *66*(3), 733–766. https://doi.org/10.1007/s11423–018-9574–1

Iordanou, K. (2022). Supporting strategic and meta-strategic development of argument skill: the role of reflection. *Metacognition and Learning*, *17*, 399–425 https://doi.org/10.1007/s11409–021–09289–1

Jeong, S., King, G., Pauli, D., Sell, C., & Steele, D. (2020). Conceptualizing Multiplicities of Scientific Literacy from Five Theoretical Perspectives. In *Science Education in the 21st Century* (pp. 3–17). Springer, Singapore. https://doi.org/10.1007/978–981–15–5155–0_1

Kalender, Z. Y., Marshman, E., Schunn, C. D., Nokes-Malach, T. J., & Singh, C. (2019). Why female science, technology, engineering, and mathematics majors do not identify with physics: They do not think others see them that way. *Physical Review Physics Education Research*, *15*(2), 020148. https://doi.org/10.1103/PhysRevPhysEducRes.15.020148

Kurniawan, Y., Nurhaeni, I. D. A., Mugijatna, & Habsari, S. K. (2018). Gender Bias in the workplace: Should women be marginalized in engineering job?. *IOP Conference Series: Materials Science and Engineering*, *306*, 012132. https://doi.org/10.1088/1757–899X/306/1/012132

Legewie, J., & DiPrete, T. A. (2014). The high school environment and the gender gap in science and engineering. *Sociology of education*, *87*(4), 259–280. https://doi.org/10.1177/0038040714547770

Lin, S.-S., & Mintzes, J. J. (2010). Learning argumentation skills through instruction in socioscientific issues: The effect of ability level. *International Journal of Science and Mathematics Education*, *8*(6), 993–1017.

Mathis, C. A., Siverling, E. A., Glancy, A. W., Guzey, S. S., & Moore, T. J. (2016, June 26–29). Students' use of evidence-based reasoning in K-12 engineering: A case study (Fundamental) [paper presentation]. *ASEE 123rd Annual* meeting, New Orleans, LA.

Murphy, P. K., Greene, J. A., Allen, E., Baszczewski, S., Swearingen, A., Wei, L., & Butler, A. M. (2018). Fostering high school students' conceptual understanding and argumentation performance in science through quality talk discussions. *Science Education*, *102*(6), 1239–1264. https://doi.org/10.1002/sce.21471

Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through stem education project-based learning. *Jurnal Pendidikan IPA Indonesia*, *7*(1), 54–65. https://doi.org/10.15294/jpii.v7i1.10495

Nagdi, M., & Roehrig, G. (2020). Identity evolution of STEM teachers in Egyptian STEM schools in a time of transition: A case study. *International Journal of STEM Education*, *7*(1). https://doi.org/10.1186/s40594–020–00235–2

NGSS. (2013). *Next generation science standards: For states, by states*. National Academies Press.

Noroozi, O., & Hatami, J. (2019). The effects of online peer feedback and epistemic beliefs on students' argumentation-based learning. *Innovations in Education and Teaching International*, *56*(5), 548–557. https://doi.org/10.1080/14703297.2018.1431143

Oon, P. T., Cheng, M. M. W., & Wong, A. S. L. (2020). Gender differences in attitude towards science: Methodology for prioritising contributing factors. *International Journal of Science Education*, *42*(1), 89–112. https://doi.org/10.1080/09500693.2019.1701217

Osborne, J., Erduran, S., & Simon, S. (2004). Enhancing the quality of argumentation in school science. *Journal of Research in Science Teaching*, *41*(10), 994–1020. https://doi.org/10.1002/tea.20035

Pirus, M. S. M., & Nurahmawati, H. (2020). Javanese women identity regarding 3M: Macak-Manak-Masak values. *International Journal of Culture and History*, *7*(2), 54. https://doi.org/10.5296/ijch.v7i2.18055

Prasetiyo, A. (2018). Subordination of Javanese women. *Advances in Social Science, Education and Humanities Research*, *280*, 34–38. https://www.atlantis-press.com/proceedings/basa-18/25906064

Putra, P. D. A., Ahmad, N., Wahyuni, S., & Narulita, E. (2021). Analysis of the factors influencing of pre-service science teacher in conceptualization of STEM education: Self-efficacy and content knowledge. *Jurnal Penelitian Pendidikan IPA*, *7*(Special Issue), 225–230. https://doi.org/10.29303/jppipa.v7iSpecialIssue.877

Putra, P. D. A., Sulaeman, N. F., Supeno, & Wahyuni, S. (2021). Exploring students' critical thinking skills using the engineering design process in a physics classroom. *Asia-Pacific Education Researcher*. https://doi.org/10.1007/s40299–021–00640–3

Rapanta, C. (2021). Can teachers implement a student-centered dialogical argumentation method across the curriculum? *Teaching and Teacher Education*, *105*. https://doi.org/10.1016/j.tate.2021.103404

Sampson, V., Enderle, P., & Grooms, J. (2020). Helping students understand the nature of scientific argumentation so they can meet the new science standards. *The Science Teacher*, *36*(4), 30–33. https://my.nsta.org/resource/?id=10.2505/4/tst13_080_05_30

Shin, S., Rachmatullah, A., Roshayanti, F., Ha, M., & Lee, J. K. (2018). Career motivation of secondary students in STEM: A cross-cultural study between Korea and Indonesia. *International Journal for Educational and Vocational Guidance*, *18*(2), 203–231. https://doi.org/10.1007/s10775–017–9355–0

Songsil, W., Pongsophon, P., Boonsoong, B., & Clarke, A. (2019). Developing scientific argumentation strategies using revised argument-driven inquiry (rADI) in science classrooms in Thailand. *Asia-Pacific Science Education*, *5*(1). https://doi.org/10.1186/s41029–019–0035–x

Steegh, A. M., Höffler, T. N., Keller, M. M., & Parchmann, I. (2019). Gender differences in mathematics and science competitions: A systematic review. *Journal of Research in Science Teaching*, *56*(10), 1431–1460. https://doi.org/10.1002/tea.21580

Sulaeman, N. F., Putra, P. D. A., Mineta, I., Hakamada, H., Takahashi, M., Ide, Y., & Kumano, Y. (2021). Exploring student engagement in STEM education through the engineering design process. *Jurnal Penelitian Dan Pembelajaran IPA*, *7*(1), 1. https://doi.org/10.30870/jppi.v7i1.10455

Toulmin, S. (1958). *The uses of argument*. Cambridge University Press.

Wieselmann, J. R., Dare, E. A., Ring-Whalen, E. A., & Roehrig, G. H. (2019). "I just do what the boys tell me": Exploring small group student interactions in an integrated STEM unit. *Journal of Research in Science Teaching*, *May 2018*. https://doi.org/10.1002/tea.21587

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed). Sage publications.

Appendix

Appendix The question in the interview stage

1. What were your ideas for solving this problem?
2. Why did you choose that solution?
3. How was your idea working to solve the problem given?
4. What do you think about engineers and scientists? What are your career aspirations?
5. How do men and women in your area pursue their careers?

Gender roles in engineering design process activity: A small group exploration through collaborative argumentation

by Pramudya Putra

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Gender roles in engineering design process activity: A small group exploration through collaborative argumentation

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Abstract

Gender plays a crucial role in science and engineering education. This study aims to explore gender's role in an engineering design process (EDP) classroom, particularly in relation to argumentation skills. This qualitative research used a case study and focused on student behavior contributions to argumentation skills, separated by gender. The participants included 12 students (6 male and 6 female) in 8th grade who participated in a collaborative group problem-solving exercise. All activities of students in the EDP classroom were recorded and transcribed to be coded using code-driven argumentation theory (claim, data/evidence, and reasoning). According to the results, the male students were more active in constructing reasoning in argumentation skills than the female students. Additionally, the female students actively claimed scientific phenomena and communicated during the discussion stage.

Introduction

In the twenty-first century, scientific argumentation has become a skill whereby students need to conceptualize the core ideas about science. The Next Generation Science Standard (NGSS) also mentions that argumentation has become one of the engineering and scientific practices used to advance scientific thinking (NGSS, 2013). Argumentation is required to build the concept of science based on the accuracy of the evidence (Erduran et al., 2015). In addition, argumentation involves the skill of critically evaluating a claim and the reasons given to support it (Iordanou, 2022).

Argumentation can be described as a discourse in which knowledge claims are individually and collaboratively constructed and evaluated, given empirical or theoretical evidence (Erduran et al., 2015). In other words, argumentation validates the explanation of scientific phenomena between claims and evidence (Murphy et al., 2018). Research on argumentation has been conducted for science teachers and students. For example, Rapanta (2021) found that teaching methods to train students' argumentation are effective pedagogical tools. Another study showed that students' experience in selecting accurate evidence can boost their argumentation skills (Gülen & Yaman, 2019).

However, the implementation of argumentation in science classrooms is challenging. For example, if the teacher focuses only on organizing the classroom for the implementation of argumentation, students are less likely to understand the scientific concept (Diniya et al., 2021). Teachers should maintain a balance between the lesson plan in argumentation and the science concept delivered to students in the classroom (Putra, et al., 2021). Murphy et al. (2018) stated that many abstractions performed to evaluate students' argumentation in a classroom begin with introducing an evaluation model, revising the model, experimenting with the students, and observing. Furthermore, topic selection is difficult for teachers who apply argumentation in science classrooms (Guilfoyle et al., 2021). One learning approach that can facilitate argumentation skills is the engineering design process (EDP).

The EDP is a learning approach that provides students with the opportunity to develop an argument to solve a problem in a real-world context. The problem can be selected from relevant issues, sociocultural factors, or student experiences (Guilfoyle et al., 2021; Songsil et al., 2019). Moreover, activities in the EDP stages involve defining, planning, learning, designing, trying, testing, and deciding (Putra, et al., 2021; Sulaeman et al., 2021). These activities allow students to collect accurate data to support their claims for solving a given problem.

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Previous research has investigated the relation between gender differences and students' argumentation skills in science and mathematics (Kalender et al., 2019; Legewie & DiPrete, 2014; Steegh et al., 2019). Moreover, Gillies (2019) organized, in small groups, the implementation of argumentation skills in a classroom. Through collaboration, students develop interdependence among group members when they complete a task. They develop their understanding by discussing the relevant task, debating about the subject content, and clarifying the information with each other. Collaboration in a classroom is intensified when the students solve the classroom task together. Students participate more actively in the learning process in a collaborative classroom than in a non-collaborative classroom. In contrast, when a task is designed for individual students, the students focus more on the argumentation test than on the learning process. This study emphasizes the roles of female and male students in arguing in an EDP classroom to solve a problem. It aims to explore the role of female and male students in an EDP classroom in building argumentation skills through collaborative argumentation. The following are the research questions that guide this study:

1. If at all, how does gender relate to argumentation skills, including claims, evidence, and reasoning, in an EDP classroom?
2. How do students construct their argumentation skills to solve a problem in an EDP classroom based on gender roles?

Literature Review

Constructivist learning theory is essential to the idea of argumentation. Science is changing and adapting rapidly and is expected to produce new knowledge (Abell & Lederman, 2010). This knowledge needs to be supported with new evidence. The communication between the valid proof and the claim of knowledge involves argumentation skills. Students need to assess their argumentation skills to understand the science content, because they also need to consider the science content relevant to solving a real-world problem in a science classroom (Erduran et al., 2015; Jeong et al., 2020; Osborne et al., 2004).

Students' argumentation has been evaluated for many years to describe students' argumentation skills. For instance, some researchers have adopted Toulmin's argumentation model, which involves elements of argumentation: claims, reasoning/warrants, data/evidence, and backing/supportive argumentation (Toulmin, 1958). Gülen & Yaman (2019) found that implementing the Toulmin model in a science classroom can improve students' performance. However, students' classroom performance is not adequate for observation. Lin and Mintzes (2010) explored students' argumentation skills by adding an element to the Toulmin model using counter-argumentation. This element drives students to reflect on their argumentation skills based on scientific problems. This model has mainly been used to evaluate students' argumentation skills through writing so that students can carefully examine their reasoning (Songsil et al., 2019). The implementation of argumentation skills in a science classroom has recently covered claims, reasoning, and data/evidence (Sampson et al., 2020). The reasoning skills links between claim and evidence, and this model can be used to observe students' argumentation quality when they talk in group discussions (Mathis et al., 2016; Murphy et al., 2018).

However, the quality talk in science for students to build verbal argumentation in science classrooms lacks investigation. Through verbal argumentation, students can construct an increasingly sophisticated argument and improve their arguments in the disciplinary context of the scientific problem (Murphy et al., 2018). The quality of scientific argumentation can be observed through group discussions, as the individual is for the argument based on data and the evaluation of the relevant data to support the claim (Capkinoglu et al., 2020). However, teachers still face a challenge in designing argumentation practices in the classroom through group discussions. They need to develop effective classroom discussions focusing on science-based engineering practices to deliver science content and students' activities (Aranda et al., 2020). The EDP offers a teaching approach that provides students with an opportunity to collaborate to solve a given problem. Students communicate with each other to establish a durable design and evaluate it by using relevant data and scientific explanations (Putra, et al., 2021). Moreover, students can take on appropriate roles and contribute to working collaboratively (Wieselmann et al., 2019).

Researchers have analyzed female and male students' performances in science and engineering. The results show that these performances have obtained different results. First, the results show that female students perform lower than male students in science and engineering classrooms. Fredricks et al. (2018) reported that female students are more likely to get frustrated and give up in engineering design when the material is challenging. In contrast, male students are perceived as more competent in persistence and deep strategy learning to solve problems in engineering design. Evidence also shows that, in a science classroom, female students receive less attention than males in preparing the data to construct argumentation (Oon et al., 2020). Argumentation research has also compared male and female student teams formed to solve engineering problems. The results indicate that the male team pays closer attention to developing the argumentation structure than the female team (Hsu et al., 2018). Second, other research on science and related subjects has shown no significant gender gap in students' achievement, especially in undergraduate students (Cimpian et al., 2020). For middle-school students, the results obtained vary depending on the class of students. For example, females have high interest in science in grade 4, while males have high creativity in grade 8.

The gender gap in science and engineering classrooms also appears in Indonesia, especially on Java Island. Mutakinati et al. (2018) investigated the motivation of middle-school students toward science and engineering careers. The results showed that female students were less motivated to pursue a career in the engineering field. Other researchers have also indicated that female middle-school students on Java Island are slightly less interested in engineering jobs (Shin et al., 2018). In particular, females hold stereotypes that they are marginalized in engineering jobs (Pirus & Nurahmawati, 2020). They tend to take care of their families, including their children (Kurniawan et al., 2018). In other words, the Javanese culture represents that women/wives are positioned under men/husbands (Prasetiyo, 2018). This study explored how gender roles contribute to the collaborative group discussion to develop argumentation rather than comparing genders. An EDP classroom was applied to facilitate students' argumentation skills through cross-gender group discussions involving male and female students.

Methodology

This study used qualitative methods, specifically a single-case method, to develop an engineering design project. The single case study focused on female and male behaviors to understand how the students participated in collaborative group discussions to develop argumentation skills (Yin, 2018).

The engineering phenomenon in the EDP classroom was related to a real-world problem on the specific topic of "heat transfer." Students were given a letter problem and asked to solve it through a group discussion in a cross-gender group. The problem is defined as follows: A village has limited electricity resources, but the people in that area should store the food longer and have good-quality food. The challenge of EDP treatment, as written in the letter, was that the students should design a solution based on the requested criteria and some constraints. The schedule in the EDP classroom is described in Table 1.

Table 1 EDP activities in the research classroom

EDP Process	Day	Student task
Problem Scooping	1st	Students analyze the engineering work.
Define	2nd	Students analyze the problem letter, write the user needs, and constrain the requested design.
Plan	2nd	Students work individually to design a solution to the problem statement and write it on the student worksheet.
Learn	3rd	Students evaluate the suitable science concepts based on their individual designs.
Design	4th	Students work in their groups to evaluate their design and discuss the best design to solve the problem by collecting evidence.
Try	4th	Students in their groups try their design and analyze the strengths and weaknesses of their design.
Test and Decide	5th	Students test their group design by presenting it to other groups and simulating their design to solve the problem.

Participants

In this study, 12 junior middle-school students (six male and six female) participated in the EDP classroom. All participants were in grade 8 in a public school in one of the provinces in East Java. Each group comprised two male and two female students. The participants' demographics are described in Table 2.

Table 2 Participants' demography in the EDP classroom

Character	*n*	% of Participants
Grade 8	12	100
Gender		
Male	6	50
Female	6	50

Data Collection

The data collection began when a teacher introduced the EDP to the students and explained the problem letter to them. Data were collected within five days of the students joining the EDP classroom (Table 1). The discussion was recorded both visually and in audio. The recording, which was transcribed and coded, became the data for extracting the science and engineering statements. To assess the credibility of the data, the authors also evaluated the EDP students' worksheets and interviewed them on the last day of the EDP class. Each interview lasted approximately 20–30 min. in accordance with the open-ended interview protocol (see Appendix).

Data Analysis

Two codes were developed to analyze the students' transcription: A theory-driven code, which focused on the discussions that the students conducted when solving the problem in small groups, and a data-driven code, which focused on the students' individual interviews about the experience of being involved in a collaboration group.

The theory-driven code was analyzed using argumentation indicators, with three indicators covering claims, evidence, and reasoning. The code for the collaborative argumentation is described in Table 3.

The data-driven code was utilized for analyzing the interview data of each student. It focused on analyzing how students constructed their argumentation skills to solve the given problem. This code is described in Table 4.

All authors observed the EDP followed by the students, transcribed, and coded the interview data of each student based on the codebook. Next, they conducted a group discussion to develop a justification for gender roles in the EDP classroom and students' construction of argumentation. Atlas. Ti was used as the software to assist in organizing the students' statements.

Results

This study described and analyzed student engagement in developing argumentation, particularly the performance of female and male engineering and science students, in solving engineering problems. Figure 1 describes the students' performance in solving the problem design and the effectiveness of the design through collaborative group discussions.

According to Figure 1, the students were generally more able to express their claims by explaining scientific phenomena rather than revealing the reasons why the existing phenomena occurred. The students had no adequate skills to scientifically explain how the evidence supported their claims. In addition, they often made claims based on their opinions without referring to data or evidence. As a result, the students could not explain why they selected the claim to solve the given problem. Male students were more dominant in the discussion and showed a greater variety of argumentation than female students.

Vignette (1) shows an example in which the students shared equipment to store food. In this episode, female students initiated the discussion and expressed their claims without supporting reasoning and adequate evidence. In this vignette, the example of the discussion process was initially worded in [P] for female students and in [L] for male students. A male student added evidence to support his claim

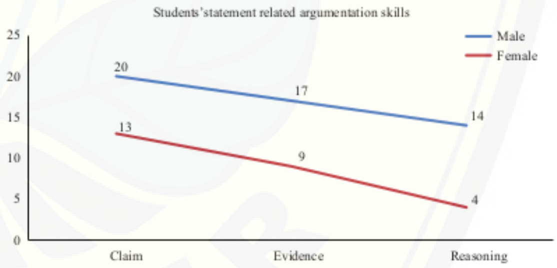

Figure 1 Comparison of argumentation skills of male and female students in the EDP classroom

Table 3 Theory-driven code used in this study

Code	Description
Claim	An opinion, result, or explanation proposed in solving a given problem
Evidence	Data or observations used to support claims
Reasoning	Reason for deciding that the support (data) is very important in proving the claim

Table 4 Data-driven code used in this study

Code	Description
Experience	Students' answers are related to their daily life experiences
Constraint	Students refer to the given problem letter and emphasize the constraint in the letter.
Science Concept	Students explain the scientific concept to be used to solve the problem.
Engineering	Students think of a prototype design to solve the problem.
Budget	Students refer the budget given or standard to create the prototype.

using scientific reasoning skills—the male student L1-1 connected the claim, evidence, and reasoning for expressing his argumentation skills. Vignette (1) shows the discussion of group 1 when trying to solve the problem. The members of this group involved [P1–1], [P2–1], [L1–1], and [L2–1].

Vignette (1)

[P1–1]: Based on this latter problem, hmm…[thinking] in my opinion, I would make pottery.

[P2–1]: Okay, I agree with you. The concepts for this problem are heat and temperature, right?

[L1–1]: hmm…[thinking for 32 seconds], How is it about heat transfer?

[P1–1]: Why is it the concept of heat transfer?

[L1–1]: Based on our experiment, pottery is able to hold the temperature inside. So, we need two pottery containers of different sizes: the smaller one inside the bigger one to store the food. This concept is related to heat transfer. (L1–1 explains and shows their design.)

[L2–1]: It's true that heat can't penetrate pottery or pottery can withstand that temperature (Gives reinforcement). Then the other size pottery container is made to contain the sand and its contents, such as food and drink." (Give opinion. See figure 2 to described the student's design)

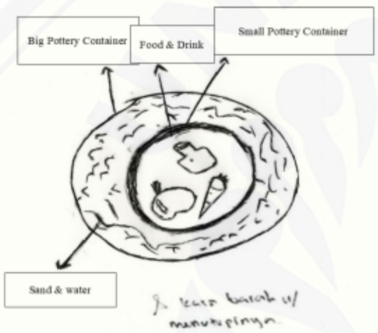

Figure 2 The student's design

In another episode, the students collected the data, but the data could not support their reasoning. Vignette (2) shows the discussion process in group 2. The students collected evidence based on a story to solve the problem. In this discussion, the female students directed the male students to stay focused on the constraints of the problem. The members of group 2 involved [P1–2], [P2–2], [L1–2], and [L2–2].

Vignette 2

[P1–2]: So... what do we need to solve the problem?

[L1–2]: Solar cells to collect energy.

[L2–2]: I need to think about it; wait in a minute [thinking for 23 seconds]. The problem is the limitation of electricity based on the story.

[P1–2]: The problem is that people in the village complain that they cannot store fruit and vegetables longer, such as when they are put in the refrigerator, and have difficulty getting cold water during extreme weather. (Give an opinion according to the phenomenon that occurs.)

[L1–2]: I agree with you!

[L2–2]: Yes, it is true. Next, what is needed to solve the problem?

[L1–2]: We need a portable refrigerator because the refrigerator could keep the food longer and keep the food in good condition.

[P1–2]: How does it work? (no one answered the problem given)

In group 3, the students also developed their collaboration skills to solve the problem. The discussion process is described in vignette 3. In this episode, the students expressed their opinions more about engineering to solve the problem. They designed a tool that can store food effectively. Group 3 consisted of students [P1–3], [P2–3], [L1–3], and [L2–3].

Vignette 3

[P1–3]: We need a material that can withstand heat from the outside, right?

[L2–3]: How do we design a two sizes wooden block?

[L1–3]: That's right, we place the wet cloth between the two blocks as a barrier to heat generation from the outside.

[P2–3]: Could you explain how it works?

[L1–3]: The heat transfer from outside will be blocked by the wet cloth and the food and drink in the inside can stay fresh.

In constructing the argumentation, the students involved some aspects in attempting their reasoning (Table 3). In the interview process, the authors deeply explored how the students understood their group design to solve the problem. The students explained the design based on their experiences, constraints, budget, and scientific concepts. The frequency of the students' statements when they were interviewed is described in Table 5.

The interview data showed that female students were not sufficiently interested in engineering-related activities. [P1–2] stated that she preferred to solve the theoretical part of the science problem rather than the engineering design. She was also keen to read the science book but lacked the ability to perform experiments in the science laboratory. [P2–1] enjoyed studying literature because she could express her art through writing activities. [P2–1] explained that her opting for arts is related to Javanese culture, where women should be softer than men, including how to communicate. The male statements contrasted with the female statements. [L1–1] stated that the design of the problem solution was a challenge for him. He preferred to perform experiments to collect evidence in the science classroom.

Discussion

This study aimed to focus on the construction of students' argumentation skills in an EDP classroom through collaborative groups based on gender roles. The male and female students were assigned in small groups to express their roles in collaborative

Table 5 Students' argumentation construction in the EDP class

Aspect to Construct Argumentation	Male	Female	Example
Experience	4	2	"Pottery is more effective because the materials used are easy to obtain and, based on experience, can be easily used."
Constraint	1	4	"That area requires a refrigerator that does not use electrical energy directly. Maybe the people there should make more use of the resources there."
Science concept	5	3	"This pottery is not easily penetrated by heat; therefore, we review the concept of heat transfer."
Engineering	3	1	"That's the shape of the pottery; it should be conical so that it cools quickly. As a result, we have a slight decrease in temperature."
Budget	0	1	"We should consider the budget. It would be good if the cost could be decreased."

argumentation. In general, male students had more of an opportunity to show argumentation than female students in the classroom. This result is in line with that obtained by previous research showing that male students pay more attention to engineering and science tasks than female students in EDP classrooms (Nagdi & Roehrig, 2020; Oon et al., 2020; Wieselmann et al., 2019). Female students' lack of interest in mathematics and science explains why they are less keen than males to participate in engineering tasks (Steegh et al., 2019). This situation is also related to the social culture on Java Island, where females show a soft attitude (Pirus & Nurahmawati, 2020). From the Javanese perspective, the female will take care of her family, including praying for her husband and kids to be successful (Kurniawan et al., 2018).

In vignettes: (1) and (2), the female students initiated the discussion by communicating their claims in their respective groups. They frequently claimed about phenomena using scientific concepts but lacked the skills to express their reason why the claim was raised with support from the relevant collected data. This result indicates that female students were more engaged in the science task at the beginning; however, their motivation gradually decreased, mainly in engineering tasks (Fredricks et al., 2018). Moreover, the female students paid more attention to planning to keep the focus on the topic in constructing their argumentation skills by verifying the constraints in the problem letter. This result also supports previous research showing that female students tend to plan and communicate collaborative argumentation skills (Hsu et al., 2018).

The collaborative argumentation between male and female students was a good structure for solving the problem in the EDP classroom. The students supported each other based on their behavioral roles. Female students gave an idea of science concepts at the beginning, although the concepts were not adequate for explaining scientific phenomena properly. This study showed that the female students started communicating more in the discussion stage. Otherwise, the males better understood the connection between reason and the selected data to explain the claim. Male students focus on the concept of science and engineering based on the female students' claims (Oon et al., 2020; Wieselmann et al., 2019).

When some students discover a claim in the beginning, it forms the basis for the other students to establish good reasoning to solve the given problem. In other words, collaboration based on student roles reveals that students use previous peers' answers as complementary knowledge (Noroozi & Hatami, 2019). Female students dominate collaborative argumentation in support of building qualitative argumentation. They remind the group to review the constraints repeatedly to ensure that the group design is appropriate for the user.

This research also showed that the students related their experiences with science concepts more when constructing their argumentation skills. This study reinforced the need for a real-world problem to be brought into the context of a science lesson so that students use their experiences to solve their daily problems (Putra, et al., 2021). Students' experiences can guide them to take alternating roles in solving a problem in the EDP classroom to build argumentation (Gülen & Yaman, 2019). Table 2 shows that the students' experiences were valuable in constructing their argumentation. In vignette (2), the students used science concepts to develop their argumentation in the classroom. The students analyzed the letter and connected it with the science concept to make a decision to solve the problem. Content analysis in argumentation is a point for developing reasoning to support a student's claim (Dönmez et al., 2021). In an EDP classroom, students should understand the need of the end user to solve the problem, so that, in the construction of the argumentation skills, the female students pay attention to the constraints of a contract among the claim, evidence, and constraints (Putra, et al., 2021; Sulaeman et al., 2021).

Conclusion and Recommendations

Our study showed that, through the EDP, classrooms facilitate students' development of argumentation skills through small-group discussions. Thorough collaboration between female and male students provides each student with an opportunity to contribute to explaining scientific phenomena through argumentation. Based on our analysis of the argumentation gender gap, we contribute to the role of female and male students in building argumentation rather than merely justifying the poor performance of female and male students in science and engineering. The study results indicate that when teachers or researchers implement science or engineering classroom activities, they should notice the gender role and how they group students to work in collaboration. The EDP activity appreciates the smallest individual contribution in a science or engineering classroom. Teachers can implement the EDP in the classroom so that students are active in discussing and working together, especially in science subjects.

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Conflict of Interest

The authors declare that there is no conflict of interest.

Reference

Abell, S. K., & Lederman, N. G. (2010). *Handbook of research on science education*. Routledge.

Aranda, M. L., Lie, R., Selcen Guzey, S., Makarsu, M., Johnston, A., & Moore, T. J. (2020). Examining teacher talk in an engineering design-based science curricular unit. *Research in Science Education*, *50*(2), 469–487. https://doi.org/10.1007/s11165-018-9697-8

Capkinoglu, E., Yilmaz, S., & Leblebicioglu, G. (2020). Quality of argumentation by seventh-graders in local socioscientific issues. *Journal of Research in Science Teaching*, *57*(6), 827–855. https://doi.org/10.1002/tea.21609

Cimpian, J. R., Kim, T. H., & Mcdermott, Z. T. (2020). Understanding persistent gender gaps in STEM Does achievement matter differently for men and women? *Science*, *368*(6497), 1317–1319. https://www.science.org/doi/abs/10.1126/science.aba7377

Diniya, D., Ilhami, A., Dian Permana P, N., Mahartika, I., & Prakash, O. (2021). Kemampuan Argumentasi Ilmiah Calon Guru IPA melalui Pendekatan MIKiR selama Pandemi Covid-19 [Scientific Argumentation Ability of Prospective Science Teachers through the MIKiR Approach during the Covid-19 Pandemic]. *Journal of Natural Science and Integration*, *4*(1), 141–148. https://ejournal.uin-suska.ac.id/index.php/JNSI/article/view/12770

Dönmez, İ., Gülen, S., & Ayaz, M. (2021). Impact of Argumentation-Based STEM Activities on Ongoing STEM Motivation. *Journal for STEM Education Research*, *5*(3), 78–101. https://doi.org/10.1007/s41979–021–00062–2

Erduran, S., Ozdem, Y., & Park, J. Y. (2015). Research trends on argumentation in science education: A journal content analysis from 1998–2014. *International Journal of STEM Education*, *2*(1). https://doi.org/10.1186/s40594-015-0020-1

Fredricks, J. A., Hofkens, T., Wang, M. te, Mortenson, E., & Scott, P. (2018). Supporting girls' and boys' engagement in math and science learning: A mixed methods study. *Journal of Research in Science Teaching*, *55*(2), 271–298. https://doi.org/10.1002/tea.21419

Gillies, R. M. (2019). Promoting academically productive student dialogue during collaborative learning. *International Journal of Educational Research*, *97*, 200–209. https://doi.org/10.1016/j.ijer.2017.07.014

Guilfoyle, L., Erduran, S., & Park, W. (2021). An investigation into secondary teachers' views of argumentation in science and religious education. *Journal of Beliefs and Values*, *42*(2), 190–204. https://doi.org/10.1080/13617672.2020.1805925

Gülen, S., & Yaman, S. (2019). The Effect of Integration of STEM disciplines into Toulmin's Argumentation Model on students' academic achievement, reflective thinking, and psychomotor skills. *Journal of Turkish Science Education*, *16*(2), 216–230. https://doi.org/10.12973/tused.10276a

Hsu, P. S., van Dyke, M., Smith, T. J., & Looi, C. K. (2018). Argue like a scientist with technology: The effect of within-gender versus cross-gender team argumentation on science knowledge and argumentation skills among middle-level students. *Educational Technology Research and Development*, *66*(3), 733–766. https://doi.org/10.1007/s11423–018-9574–1

Iordanou, K. (2022). Supporting strategic and meta-strategic development of argument skill: the role of reflection. *Metacognition and Learning*, *17*, 399–425 https://doi.org/10.1007/s11409–021–09289–1

Jeong, S., King, G., Pauli, D., Sell, C., & Steele, D. (2020). Conceptualizing Multiplicities of Scientific Literacy from Five Theoretical Perspectives. In *Science Education in the 21st Century* (pp. 3–17). Springer, Singapore. https://doi.org/10.1007/978–981–15–5155–0_1

Kalender, Z. Y., Marshman, E., Schunn, C. D., Nokes-Malach, T. J., & Singh, C. (2019). Why female science, technology, engineering, and mathematics majors do not identify with physics: They do not think others see them that way. *Physical Review Physics Education Research*, *15*(2), 020148. https://doi.org/10.1103/PhysRevPhysEducRes.15.020148

Kurniawan, Y., Nurhaeni, I. D. A., Mugijatna, & Habsari, S. K. (2018). Gender Bias in the workplace: Should women be marginalized in engineering job?. *IOP Conference Series: Materials Science and Engineering*, *306*, 012132. https://doi.org/10.1088/1757–899X/306/1/012132

Legewie, J., & DiPrete, T. A. (2014). The high school environment and the gender gap in science and engineering. *Sociology of education*, *87*(4), 259–280. https://doi.org/10.1177/0038040714547770

Lin, S.-S., & Mintzes, J. J. (2010). Learning argumentation skills through instruction in socioscientific issues: The effect of ability level. *International Journal of Science and Mathematics Education*, *8*(6), 993–1017.

Mathis, C. A., Siverling, E. A., Glancy, A. W., Guzey, S. S., & Moore, T. J. (2016, June 26–29). Students' use of evidence-based reasoning in K-12 engineering: A case study (Fundamental) [paper presentation]. *ASEE 123rd Annual* meeting, New Orleans, LA.

Murphy, P. K., Greene, J. A., Allen, E., Baszczewski, S., Swearingen, A., Wei, L., & Butler, A. M. (2018). Fostering high school students' conceptual understanding and argumentation performance in science through quality talk discussions. *Science Education*, *102*(6), 1239–1264. https://doi.org/10.1002/sce.21471

Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through stem education project-based learning. *Jurnal Pendidikan IPA Indonesia*, *7*(1), 54–65. https://doi.org/10.15294/jpii.v7i1.10495

Nagdi, M., & Roehrig, G. (2020). Identity evolution of STEM teachers in Egyptian STEM schools in a time of transition: A case study. *International Journal of STEM Education*, *7*(1). https://doi.org/10.1186/s40594–020–00235–2

NGSS. (2013). *Next generation science standards: For states, by states.* National Academies Press.

Noroozi, O., & Hatami, J. (2019). The effects of online peer feedback and epistemic beliefs on students' argumentation-based learning. *Innovations in Education and Teaching International*, *56*(5), 548–557. https://doi.org/10.1080/14703297.2018.1431143

Oon, P. T., Cheng, M. M. W., & Wong, A. S. L. (2020). Gender differences in attitude towards science: Methodology for prioritising contributing factors. *International Journal of Science Education*, *42*(1), 89–112. https://doi.org/10.1080/09500693.2019.1701217

Osborne, J., Erduran, S., & Simon, S. (2004). Enhancing the quality of argumentation in school science. *Journal of Research in Science Teaching*, *41*(10), 994–1020. https://doi.org/10.1002/tea.20035

Pirus, M. S. M., & Nurahmawati, H. (2020). Javanese women identity regarding 3M: Macak-Manak-Masak values. *International Journal of Culture and History*, *7*(2), 54. https://doi.org/10.5296/ijch.v7i2.18055

Prasetiyo, A. (2018). Subordination of Javanese women. *Advances in Social Science, Education and Humanities Research*, *280*, 34–38. https://www.atlantis-press.com/proceedings/basa-18/25906064

Putra, P. D. A., Ahmad, N., Wahyuni, S., & Narulita, E. (2021). Analysis of the factors influencing of pre-service science teacher in conceptualization of STEM education: Self-efficacy and content knowledge. *Jurnal Penelitian Pendidikan IPA*, *7*(Special Issue), 225–230. https://doi.org/10.29303/jppipa.v7iSpecialIssue.877

Putra, P. D. A., Sulaeman, N. F., Supeno, & Wahyuni, S. (2021). Exploring students' critical thinking skills using the engineering design process in a physics classroom. *Asia-Pacific Education Researcher*. https://doi.org/10.1007/s40299–021–00640–3

Rapanta, C. (2021). Can teachers implement a student-centered dialogical argumentation method across the curriculum? *Teaching and Teacher Education, 105*. https://doi.org/10.1016/j.tate.2021.103404

Sampson, V., Enderle, P., & Grooms, J. (2020). Helping students understand the nature of scientific argumentation so they can meet the new science standards. *The Science Teacher*, *36*(4), 30–33. https://my.nsta.org/resource/?id=10.2505/4/tst13_080_05_30

Shin, S., Rachmatullah, A., Roshayanti, F., Ha, M., & Lee, J. K. (2018). Career motivation of secondary students in STEM: A cross-cultural study between Korea and Indonesia. *International Journal for Educational and Vocational Guidance*, *18*(2), 203–231. https://doi.org/10.1007/s10775–017–9355–0

Songsil, W., Pongsophon, P., Boonsoong, B., & Clarke, A. (2019). Developing scientific argumentation strategies using revised argument-driven inquiry (rADI) in science classrooms in Thailand. *Asia-Pacific Science Education*, *5*(1). https://doi.org/10.1186/s41029–019–0035–x

Steegh, A. M., Höffler, T. N., Keller, M. M., & Parchmann, I. (2019). Gender differences in mathematics and science competitions: A systematic review. *Journal of Research in Science Teaching*, *56*(10), 1431–1460. https://doi.org/10.1002/tea.21580

Sulaeman, N. F., Putra, P. D. A., Mineta, I., Hakamada, H., Takahashi, M., Ide, Y., & Kumano, Y. (2021). Exploring student engagement in STEM education through the engineering design process. *Jurnal Penelitian Dan Pembelajaran IPA*, *7*(1), 1. https://doi.org/10.30870/jppi.v7i1.10455

Toulmin, S. (1958). *The uses of argument.* Cambridge University Press.

Wieselmann, J. R., Dare, E. A., Ring-Whalen, E. A., & Roehrig, G. H. (2019). "I just do what the boys tell me": Exploring small group student interactions in an integrated STEM unit. *Journal of Research in Science Teaching, May 2018.* https://doi.org/10.1002/tea.21587

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed). Sage publications.

Appendix

Appendix The question in the interview stage

1. What were your ideas for solving this problem?
2. Why did you choose that solution?
3. How was your idea working to solve the problem given?
4. What do you think about engineers and scientists? What are your career aspirations?
5. How do men and women in your area pursue their careers?

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