Elementary Students’ Management of Conflicts in an Engineering Design Process and Its Effects on Their Group Interaction Progress

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**Abstract**

This study aimed to examine how students managed conflicts in an engineering design process and how different management styles affected their group interaction progress. We observed three groups of students in classes, where they designed devices to solve water shortages. Students’ interactions involving conflict in these lessons were analyzed in terms of their conflict management style. Twenty conflict-based interactions were observed in the process of engineering design, and these occurred in all groups. Most conflict-based interactions we observed were task conflicts, and students showed conflict management styles of dominating, avoiding, obliging, integrating, and compromising. These different conflict management styles led to different amounts of progress in group interactions. Avoiding and dominating terminated interactions and prevented students from developing their ideas further. Dominating and obliging caused relationship conflict. Integrating and compromising management styles led to more productive student interactions. This study suggests that further educational efforts are necessary to teach students how to effectively manage conflicts in engineering design processes.
Keywords

conflict management – elementary students – engineering design – interaction

1 Introduction

Engineering work is usually done in teams, and it is rare for an engineer to design a solution or solve a problem alone. Therefore, communication skills are essential for teamwork in engineering design. Effective communication skills refer not only the ability to write and speak in a manner that can convey information clearly and understandably but also to the ability to negotiate, manage, and resolve conflict situations in teams (Kovac & Sirkovic, 2017). Cunningham and Kelly (2017) also suggested that “working effectively in teams” and “communicating effectively” (p. 492) are a part of the epistemic practices of engineering and proposed that these practices should be considered and taught in engineering education.

Conflict is inevitable when people work together in groups (Yoon & Hong, 2018). Conflict is an interaction that can occur between two or more individuals or groups when they have opposing or different goals, interests, and values. Conflict can be categorized into task conflict and relationship conflict depending on what it is focused on (Jehn, 1995). Research has shown that these conflicts can have both positive and negative consequences when groups work together (De Dreu & Weingar, 2003) depending on how the conflicts are managed (Paulus & Dzindolet, 2008).

In science education research dealing with engineering design, previous studies have focused on students’ cognitive learning as a method of applying scientific knowledge (Kim et al., 2019) and evidence-based reasoning in their decision-making, which is often referred to as argumentation (Siverling et al., 2021). These previous studies dealt with situations that were similar to the task conflict situation mentioned in this study but were mainly analyzed by focusing on students’ cognitive learning processes in terms of students’ argumentation. Although this study deals with similar situations in terms of students’ disagreement and arguments, our aim was to interpret these situations from the perspective of the social process of communication. Therefore, this study aimed to examine how students managed the conflicts they faced in the engineering design process and how this affected their group interaction progress.
Theoretical Background

2.1 Communications and Teamwork in Engineering
Cunningham and Kelly (2017) suggested 16 epistemic practices of engineering that represent features of doing engineering work (see Table 1):

<table>
<thead>
<tr>
<th>Epistemic practices of engineering</th>
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<tbody>
<tr>
<td>Developing processes to solve problems</td>
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<tr>
<td>Considering problems in context</td>
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<tr>
<td>Envisioning multiple solutions</td>
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<tr>
<td>Innovating processes, methods, and designs</td>
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<tr>
<td>Making trade-offs between criteria and constraints</td>
</tr>
<tr>
<td>Using systems thinking</td>
</tr>
<tr>
<td>Applying math knowledge to problem-solving</td>
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<tr>
<td>Applying science knowledge to problem-solving</td>
</tr>
<tr>
<td>Investigating properties and uses of materials</td>
</tr>
<tr>
<td>Constructing models and prototypes</td>
</tr>
<tr>
<td>Making evidence-based decisions</td>
</tr>
<tr>
<td>Persisting and learn from failure</td>
</tr>
<tr>
<td>Assessing implications of solutions</td>
</tr>
<tr>
<td>Working effectively in teams</td>
</tr>
<tr>
<td>Communicating effectively</td>
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<tr>
<td>Seeing themselves as engineers</td>
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Adapted from Cunningham & Kelly, 2017

Because engineering takes place in a social context, epistemic practices such as “working effectively in teams” and “communicating effectively” were included in these 16 practices. Teamwork is required because engineers work in groups, and communication skills are also necessary when engineers work with others such as clients, artists, or even politicians (Cunningham & Kelly, 2017; National Academies of Sciences, Engineering, and Medicine [NASEM], 2020). Although these communication skills are essential to engineers, Dannels et al. (2003) reported that communication skills were challenging for students in various engineering majors as they performed team projects. These difficulties can be divided into four major categories: integrating multidisciplinary information, managing varied audiences and feedback, aligning content and
communication tasks, and addressing interpersonal team issues. Among them, students mentioned the difficulty of managing team conflict in addressing interpersonal team issues.

When many people work together, it is generally agreed that teamwork is necessary. Teamwork can be seen as an interaction process in which members collaborate on a common task. Hoegl and Gemuenden (2001) suggested six facets of the teamwork quality construct: communication, coordination, balance of member contributions, mutual support, effort, and cohesion. Their study showed that when team members helped each other, conflicts were easily resolved and the level of mutual support was high, but when there were many personal conflicts in their team, cohesion was low. This shows that whether there are conflicts in the team and how these conflicts are managed is closely related to the quality of teamwork.

2.2 **Conflicts and Conflict Management Styles**

Conflict is an interaction that can occur between two or more independent parties and arises when the interests or goals of individuals, groups, and organizations are incompatible. Views of conflict have changed over time and fall into three general categories: the traditional view of conflict, the human relations view of conflict, and the interactionist view of conflict (Robbins & Judge, 2009). The traditional view of conflict is an early approach to conflict where conflict is regarded as being negative and something that should be avoided. The human relations view of conflict, however, argues that conflict is a natural occurrence and is inevitable. The interactionist view of conflict encourages conflict when it is necessary; although not all conflicts are good, they can have positive effects if they function properly and are well managed.

Conflict can be categorized into task conflict and relationship conflict from the point of view of interaction (Jehn, 1995). Task conflict is a conflict related to the content or goal of a given task that arises when there is disagreement in the views, ideas, or opinions of group members. Task conflict has a positive function in that it enables the collection of diverse views, improves the quality of communication, and can improve the level of problem solving. However, it also has a negative function in that information-processing ability decreases as the cognitive loads increase. Relationship conflict is a conflict resulting from interpersonal differences between the people in a group regardless of the task, and it can cause negative emotions such as tension, repulsion, and annoyance (Hülsheger et al., 2009). This has a negative function that interferes with task performance, as the expression of negative emotions causes the energy of the members to be consumed in relationships that are not related to the task.

Depending on how conflict is managed, conflict can have a positive or negative effect on a group’s process (Paulus & Dzindolet, 2008). Tekleab et al. (2009)
reported that conflict management affected team cohesion. They found that the ability to manage conflict effectively not only directly affects team cohesion, but also modifies the way relationship conflict and task conflict, respectively, influence team cohesion in positive and negative ways. Previous studies have categorized conflict management styles into five categories based on concern for self or others: integrating, compromising, avoiding, obliging, and dominating (Rahim & Bonoma, 1979; Rahim & Magner, 1995; Rahim & Katz, 2019). As shown in Figure 1, one dimension represents the degree to which a person attempts to satisfy their own personal concerns, while the other represents the degree to which a person attempts to satisfy the concerns of others.

The integrating style involves high concern for others and high concern for self. This style seeks to exchange information, examine differences, look for alternatives, and show openness to reach a solution acceptable to both parties. The compromising style is a middle ground where both parties need to give something in order to take something. This style seeks to reach a point that is mutually acceptable to all parties. The avoiding style shows low concern for both self and others. This style involves avoiding conflict by withdrawing from decisions or sidestepping situations to avoid decisions. The obliging style shows low concern for self and high concern for others. This style aims to satisfy the needs of others and accommodate and accept others’ opinions by giving up personal concerns. The dominating style shows high concern for self and low concern for others. This style is associated with a person forcing behavior to obtain a favorable solution for themselves and ignoring the needs of others.

**Figure 1**
The dual concern model of styles of handling interpersonal conflict
Adapted from Rahim & Katz, 2019
3 Research Methods

3.1 Research Context
This study used a single case study to explore how students managed the conflicts they faced and how this affected their group interaction progress. This case study was conducted in an elementary school science context in an engineering design class. Although engineering design is not explicitly addressed in the elementary school science curriculum in Korea, engineering design is mentioned in the “journey of water” unit of the 2015 Revised Elementary Science Curriculum (MOE, 2015) for the fourth grade. For this reason, we selected the journey of water unit and planned an activity to design a device to solve water shortage problems.

This unit involved 10 lessons (see Table 2), with the following topics and activities: The first two lessons dealt with making a collaborative and supportive environment for engineering design in groups. The next five lessons dealt with the scientific concept of the water cycle and water shortage issues. The

<table>
<thead>
<tr>
<th>Lesson topics</th>
<th>Main activities</th>
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<tbody>
<tr>
<td>1–2 Establishing a collaborative classroom environment</td>
<td>Reading the story of the “blue chair” (Boujon, 2004) to learn about the importance of respect for diversity of opinion. Playing games to create empathy and a supportive atmosphere.</td>
</tr>
<tr>
<td>3 Introducing water shortage problems</td>
<td>Reading the story “I want to drink clean water” to provide context for water shortage problems. Imagining what could happen if water shortage problems continue.</td>
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<tr>
<td>4–5 Learning scientific concepts about the water cycle</td>
<td>Learning scientific concepts about the water cycle that can be applied when designing devices to solve water shortage problems.</td>
</tr>
<tr>
<td>6 Learning the importance of water</td>
<td>Investigating cases where water is used. Explaining the importance of water.</td>
</tr>
<tr>
<td>7 Understanding water shortage problems</td>
<td>Investigating the situation in many countries experiencing water shortage problems.</td>
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</table>
last three lessons were about designing a device to solve water shortage issues. The main focus of this research is Lessons 8 and 9, which dealt with designing a device to solve water shortage problems.

Ten lessons were conducted for the journey of water unit, with the first two lessons dealing with creating a supportive environment for teamwork. The next five lessons dealt with the scientific concept of the water cycle and water shortage problems. The last three lessons were about designing a device to solve water shortage problems.

This research took place in elementary school science lessons in Korea that were taught by one of the researchers. The school was a public school located in Seoul, Korea. The participant teacher was one of the researchers and was an elementary teacher with 4 years of experience at this school. There were 21 students in the class working in five groups. Three of the five groups of students who consented to participate in this research were selected as focus groups. Twelve students participated in this study, with two boys and two girls in each of the three groups.

3.2 Data Collection and Analysis
For the data collection, the last three lessons dealing with designing devices were audio- and video-recorded, and students’ discourse in the focus groups was transcribed. Students’ artifacts such as brainstorming and drawing of devices for solving water shortage problems, were collected. For the data analysis, all of the audio data collected were transcribed, and the transcriptions were organized based on which step the discourse they represented, such as sharing individual brainstorming about devices, group discussion to design a group device, and modification of group device design. Each step was divided

<table>
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<tr>
<td>8–9</td>
<td>Designing a device to solve water shortage problems. Imagining and drawing a device individually to solve water shortage problems. Brainstorming and sharing ideas in groups. Designing a device in groups to solve water shortage problems through group discussion.</td>
</tr>
<tr>
<td>10</td>
<td>Promoting the designed device Promoting the device to address water shortage problems.</td>
</tr>
</tbody>
</table>
into smaller episodes when the topic of conversation changed. For instance, an episode of group discussion aimed at designing a group device was divided into episodes such as visualization of an idea and application of scientific knowledge.

We then coded students’ interactions into three categories according to how their ideas were addressed: interactions in which students’ ideas were collected and accumulated, interactions in which students’ ideas were inconsistent, and interactions in which students’ ideas were synthesized. Interactions in which students’ ideas were inconsistent were coded as conflict-based interactions and were the main interactions analyzed in this study.

Conflict-based interactions were then coded into five categories according to conflict management style: dominating, avoiding, integrating, compromising, and obliging (Rahim & Katz, 2019).

In order to secure the credibility of data analysis, a lesson was analyzed individually by one of the researchers and a science education researcher. Eighty-five percent agreement was reached, and all disagreements were discussed. After discussion, the first author analyzed the rest of the data.

4 Findings

Twenty conflict-based interactions were observed in the process of engineering design, and these conflict-based interactions were observed in all groups. Three conflict-based interactions were observed in Group 1, eight in Group 2, and nine in Group 3. In the observed conflict-based interactions, the development of each interaction was different depending on how the students responded to the conflict they faced. When there was conflict, students’ dominating and avoiding responses to the conflict prevented the interaction from developing productively. In particular, responding dominantly to conflicts tended to turn task conflicts into relationship conflicts. Obliging in conflict also caused relationship conflict, as it did in dominating, but relationship conflicts caused by obliging were covert in contrast to the overt relationship conflicts caused by dominating. In addition, while obliging in conflict caused covert relationship conflict, it did not stop students’ interaction, and these interactions tended to develop into ones in which students were able to synthesize their ideas. When conflicts were responded to in integrating and compromising ways, they tended to develop into productive interactions. More detailed examples will be described below.
4.1 The Avoiding Conflict Management Style: Terminated Interactions

When there were conflicts between students, the avoiding and dominating management styles tended to prevent further interaction. Seven of the 20 cases featured the avoiding conflict management style. Students avoided conflict by changing the topic of conversation. The episode below shows Student 3 trying not to argue by saying he did not know when Student 2 asked a question that opposed Student 3’s opinion.

Episode in Group 1
Student 03: Rain falls here. Then it is disinfected through here and stored here.
Student 02: But how does [water] get in it?
Student 03: You know, sucking ...
Student 02: (with an aggressive tone) How does this device work?
Student 04: The vacuum cleaner here?
Student 03: I don’t know, ha ha ha. I like simple things.

Another example of the avoiding management style is trying to act as if the conflict never happened by ignoring opinions. In the below episode, other group members were discussing whether to remove or add a zipper bag to make a device that obtains water by evaporation due to the temperature difference during the day. However, when Student 12 said that boiling would be faster than evaporating naturally and mentioned installing a pot, the other students tried to avoid a conflict by ignoring Student 12’s opinion. This was not the first time Student 12 had mentioned the pot, and it seemed that the students were trying to avoid the conflict by ignoring Student 12’s comments as there had been conflicts before.

Episode in Group 3
Student 09: Then, do we remove the zipper bag?
Student 04: Yes.
Student 11: Yes.
Student 10: What do we need to put (instead of the zipper bag) then? We cannot just do it with water vapor?
Student 12: (in a small voice) We can do it with a pot.
Student 09: (pretending not to hear it and looking at Student 11) How do we draw then?
Student 12: (in a louder voice) Can we do it with a pot? (each student started drawing and writing with no response to Student 12)
Student 09: (drawing) container and raindrops
As in the cases above, when conflict situations were avoided by changing the topic of conversation or ignoring opinions, the interaction tended to be terminated without any further interaction occurring, and the ideas were not synthesized and developed.

4.2 The Dominating Conflict Management Style: Overt Relationship Conflict and Terminated Interactions

The dominating conflict management style tended to hinder student interaction and cause relationship conflicts resulting in negative interactions. The episode below shows a dominating conflict management style where a student ignored the other students’ feedback and tried to carry out his own idea.

**Episode in Group 3**

Student 12: *(pointing to the device he drew)* Rain comes in, a fire is made here, and there is a boiling phenomenon here and it turns into steam. Here is a towel with cold water on it. It is condensed here on the towel and [water drops] fall here. This is a plastic bottle here, inside. *(Explaining while looking at Student 10)*

... 

Student 10: No, doesn’t it collect here?

Student 12: *(with his eyes wide open and aggressive)* Why is it collecting?

Student 10: It can collect, water vapor can. Here, on the side [of the straw].

Student 12: Why does the water vapor collect there? The water vapor goes upwards.

Student 12: Water vapor usually goes this way.

Student 10: It might come down.

Student 12: *(with a louder voice)* Downwards ... because it cannot go downwards.

In this episode, Student 12 shared his idea with his group. After that, Student 10 asked the question of whether the water vapor not only condenses on the towel and falls to the bottom but also condenses on the side of the straw designed to let the water vapor out. Instead of elaborating his idea by accepting feedback from others, Student 12 affirmatively evaluated that this does not make sense and indicated that he felt he was right. This was coded as the dominating
management style, as Student 12 did not work cooperatively with others and behaved assertively to carry his idea through. Afterward, this group faced the conflict again with the same problem, and Student 12 showed the dominating conflict management style again.

**Episode in Group 3**

Student 12: This is a pot. Make a hole in the pot and make a fire, then it becomes steam. Water, as there is fire, water vapor is here in this glass straw. It goes in and out.

Student 10: How does it get out?

Student 12: *(With louder voice)* Here, water vapor enters this end [of the straw] and comes out this [end of the straw].

...  

Student 12: Here is the pot. Here is a pot lid.

Student 10: Why do you keep explaining?

Student 11: I know what you are explaining, but that is what you already explained. I don't understand what you are explaining. No matter how much you explain, I don't understand.

Student 12: So I am trying to explain in an understandable way!

Student 11: No, I don't understand ...

Student 12: *(with a louder voice)* No! So let me explain, explain to understand!

Student 11: *(touching forehead)* Ha ... Because you keep repeating the same words over and over again.

Student 12: *(with a louder voice)* I am not repeating the same words!

In this episode, Student 12 kept explaining about this device and tried to convince the other students. However, in the process of trying to persuade others of the correctness of his opinion, he continued to explain his opinion in detail and did not try to consider what others thought about his opinion. Due to Student 12’s dominating conflict management style, conflict-based interactions continued and the group did not make any progress with their ideas. In addition, relationship conflicts were indicated by students shouting angrily and putting their hands on their foreheads. After this conflict, Students 10 and 11 complained about why their group was not happy, showing that this group had a relationship conflict because of Student 12’s dominating conflict management style.
4.3 The Obliging Conflict Management Style: Covert Relationship Conflict

Obliging in conflict also caused relationship conflict, but in this case it was covert. The relationship conflict due to the dominating conflict management style in Group 3 was obvious because they gave voice to their anger. Relationship conflicts due to the obliging management style, however, were not revealed on the surface. In the episode below, Student 8 frowned without getting angry or making a louder voice and decided not to participate in the discussion after the conflict.

Episode in Group 2

Student 05: Is this water?
Student 08: Collect the water, seawater here.
Student 07: Is this a plastic bottle?
Student 08: No.
Student 07: Is this a glass bottle?
Student 08: Yes.
Student 07: Why is it a glass bottle?
Student 05: Do you boil water in a glass?
Student 07: It is not something you just can do like that.
Student 08: Ah .... (trying to explain but giving up)
Student 05: You don’t know right?
Student 07: Yours is out. (Everyone is modifying their own drawing and Student 8 is putting his drawing aside.)

The researchers observed that there was a relationship conflict through the fact that Student 8 no longer participated, but it seemed that by not saying anything to Student 8, either the students and teacher did not notice the relationship conflict or it may not have been brought to the surface.

This aspect of relational conflict can lead to worse results than the aspect of relational conflict shown in dominating, because covert conflicts are less likely to provide opportunities or support from others such as the teacher to solve the problem while overt conflicts can be actively supported by others (Katz et al., 2016).

4.4 The Integrating and Compromising Management Styles: Productive Interaction

When students compromised or integrated in conflict-based interactions, students tended to synthesize and develop their ideas. The integrating conflict management style seeks satisfaction from both self and others to find a
win-win outcome. In the example below, Student 10 came up with a new idea when Student 12 asked how to collect evaporated water. However, there was an objection to the scientific validity of this part and conflict arose. After that, students called the teacher as a mediator to confirm the correctness of the scientific concept that was applied to the idea and started listening to the teacher’s explanation. Based on the teachers’ explanation, students in Group 3 combined ideas to elaborate and decide on the device. In the end, they resolved the conflict in a way that satisfied everyone. However, the decisive moment for integrating conflict management was not made by the mediation of the teacher but rather by the mediation of group members.

**Episode in Group 3**

**Student 12:** But it happens from that side, and the rain evaporates and comes out this way. But how is it going to become water when it comes out of this side?

...  

**Student 12:** No, it can become water when it meets the cold.  
**Student 10:** No. Teacher, can water vapor just become water?  
**Teacher:** A device is necessary.  
**Student 10:** Then it becomes something like this. Just like we did last time, put it in a zipper bag and evaporate the hot stuff, and when it goes up, it becomes water droplets and comes down!  

...  

**Teacher:** Look, we did not just leave the water, we put ice on it. As the ice melts, the water turns into water vapor. When we just leave water, it evaporates when it is hot but if not, it will not evaporate well. And as this is not a zipper bag, the droplets cannot form well. You need very hot sunlight to make this evaporate.

**Student 09:** Then, does it work if we use the sunlight area?  
**Student 10:** Hot area!  
**Teacher:** Or you can do it easily when you boil it like Student 12 said.  
**Student 10:** Then boil it.  
**Student 09:** Boil it instead.  
**Student 12:** Boiling is faster than evaporation.  
**Student 09:** Yes, yes! Let’s combine!  
**Student 10:** Yes.
The students tended to be able to develop their ideas in their groups when the compromising conflict management style was used. The compromising conflict management style seeks to arrive at an acceptable solution for all by each giving up a little for their own and others' satisfaction. This compromising management style was found in Group 3. Although the same topic had been discussed before, students at that time used dominating and avoiding conflict management styles, so their discussion could not develop further. However, the compromising conflict management style helped this group move forward to develop their ideas. This is because Student 12's attitude toward dealing with conflict changed.

Episode in Group 3

Student 12: *(Looking at Student 10)* You said that it collects. Then just wrap a towel around [the straw].

... 

Student 09: *(Finishing drawing)* Done.

Student 10: What do we do next? All done? But it does not work. When it boils, the pot is full of water. Then there must be something like a straw on top.

Student 09: *(Giving a piece of paper)* Draw it, you guys. I don't know what it is.

Student 12: So what I was thinking *(showing a drawing)* was like this. Water, filter paper, this is water vapor. Going up and [becoming] water.

Student 10: *(Drawing what Student 12 said)* Drawing a straw here and .... I am not good at drawing the straw. Done.

Student 12: You cannot draw like that.

Student 10: Do you want me to draw this big? Round?

Student 12: No, it has to be tilted a little like this. Yes, it shouldn't be tilted too much. Oh, yes, that's it. And put it on top of something like a plastic bottle.

Student 10: Like this?

Student 12 does not repeat his explanation in order to try to force his idea and carry out his opinion as he did before. Instead, he modified his idea slightly based on another student's idea and suggested it to the others. This conflict-based interaction using the compromising management style occurred because the student yielded some of the ideas he had initially suggested in such a way that the other students could accept them. This conflict management style led to the development of discussion and the refinement of their device.
Summary and Conclusions

This study aimed to examine how elementary students managed the conflicts they faced in an engineering design process and how different management styles affected their group interaction progress in different ways. We observed three groups of students during lessons in the journey of water unit aimed at designing devices to solve water shortages. Students’ interactions in these lessons were analyzed and when there were conflicts, the students’ interactions were analyzed according to the conflict management styles they used.

Twenty conflict-based interactions were observed during the engineering design process in these lessons, and conflict-based interactions were observed in all groups. Most conflict-based interactions we observed were task conflicts. As this study examined students’ interactions in groups that had a common goal of devising a device to solve water shortages, most conflicts were task conflicts due to disagreements about the common task. Previous studies have reported that task conflict improves the quality of decision-making and builds a constructive organization process (Cheong, 2016). All of the conflict-based interactions observed in this study started as task conflicts, but some changed to relationship conflicts. The results showed that conflict type changed from task to relationship conflict because students’ feelings were hurt by the conflict management style during the task conflict. This shows that another conflict can occur depending on how the conflict is managed.

In this study, we found that students used the conflict management styles of dominating, avoiding, obliging, integrating, and compromising that Rahim and Katz (2019) suggested. These conflict management styles led to different types of interactions. Avoiding and dominating terminated interactions and prevented students from developing their ideas further. Dominating and obliging caused relationship conflict. Overt relationship conflict occurred after the use of the dominating management style, and covert relationship conflict was observed after the use of the obliging management style. Integrating and compromising management styles led to productive student interactions. This result aligns with Farh et al. (2010), who reported that moderate levels of task conflict led to optimal levels of collective creativity. Farh et al. reported a curvilinear effect of task conflict on collective creativity and suggested that it is important to manage conflict well so that creative output can be obtained by maintaining the optimal conflict level. Previous studies have also generally viewed integrating, compromising, and obliging as positive conflict management styles (Cheong, 2016); however, dominating and avoiding have not been considered effective conflict management styles in that they interfere with productive interaction and lower team performance (Bishop et al., 2000;
Kim & Tak, 2015; Tjosvold, 2008). This study also showed that dominating and avoiding had a negative effect on students’ synthesizing of their ideas and on their further interactions.

However, a difference from previous studies was that a different kind of relationship conflict appeared to be caused by the obliging conflict management style, which had not previously been considered negative. The relationship conflict caused in this way was not revealed on the surface, so the teacher did not notice that there was a relationship conflict in this group and could not mediate this conflict. The results showed that one student who experienced this type of relationship conflict ceased being active in the group discussion. This contrasts with the dominating management style, which was obvious enough to be noticed by the teacher and other students, allowing the teacher to intervene to resolve the conflict.

In previous studies dealing with K-12 education, there have been many cases in which studies of school life and friendship have been conducted by focusing on relationship conflicts between students (Wang & Fletcher, 2017). Occupational studies, however, have mainly dealt with how to deal with task conflicts in order to efficiently organize teams and improve work performance (Petrou et al., 2019). This study is meaningful in that it focuses on the conflicts students experience in projects with a common goal in engineering design, unlike previous studies on conflicts that have focused on peer relationships. Previous studies have also mainly analyzed students’ disagreements in the engineering design process in science classes through argumentation or negotiation from a cognitive point of view (Siverling et al., 2021; Jin & Geslin, 2009), but this study is meaningful in that it looked at similar situations from a social point of view. Jin and Geslin (2009) reported that engineers frequently face conflicts in the process of engineering design as a team and reach an agreement through a process of negotiation. They explained this situation with the concept of the zone of possible agreement, and argue that engineers should reach a mutual agreement through argumentation-based negotiation in this zone. The zone of possible agreement was also found in this study, but it was observed that argumentation for students to reach mutual agreement did or did not develop depending on the conflict management style. For example, dominating and avoiding responses to the conflict prevented the interaction from developing productively in this study. Jin and Geslin (2009) argued that it is not easy even for engineers to identify the zone of possible agreement and deal with it effectively. This study also showed that the obliging management style could deepen task conflict into covert relational conflict, which, because it is not spoken out loud, results in a situation where it is more difficult for the teacher to detect and intervene.
This study gives us implications for how teachers can use conflicts in engineering design in an educational way. For instance, teachers should be aware that conflicts in engineering design are interactions that naturally appear in the process of reaching mutual agreement, but students’ conflict may not be explicitly revealed. Teachers should pay attention to this covert conflict in order not to lead to negative consequences such as not participating in learning. In addition, it is necessary for teachers to teach students communication skills and give them opportunities to use them so that they can use conflict-management styles such as integrating and compromising rather than the avoiding and dominating styles that hinder the synthesis of students’ thinking. Students’ learning of social skills such as conflict management strategies need to be addressed together to support students’ cognitive learning.

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Ethical Considerations

The data collected from this paper has obtained the necessary clearance from the students and their guardians involved in the study.

About the Authors

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