Infinity Journal of Mathematics Education
Volume 13, No. 1, February 2024

p-ISSN 2089-6867
e–ISSN 2460-9285

https://doi.org/10.22460/infinity.v13i1.p215-232

EXPLORING JUNIOR HIGH SCHOOL STUDENTS' GEOMETRY SELF-EFFICACY IN SOLVING 3D GEOMETRY PROBLEMS THROUGH 5E INSTRUCTIONAL MODEL INTERVENTION: A GROUNDED THEORY STUDY

Sudirman[1*], Javier García-García[2], Camilo Andrés Rodríguez-Nieto[3], Aloisius Loka Son[4]
[1]Universitas Terbuka, Indonesia
[2]Universidad Autónoma de Guerrero, Mexico
[3]University of the Coast, Colombia
[4]Universitas Timor, Indonesia

Article Info

Article history:

Received Nov 19, 2023
Revised Jan 24, 2024
Accepted Jan 26, 2024
Published Online Jan 31, 2024

Keywords:

Geometry self-efficacy,
3D Geometry problem solving,
5E Instructional model

ABSTRACT

Geometry self-efficacy is an essential affective aspect that will influence students in solving mathematics problems, especially geometry material. Therefore, teachers must be able to develop learning instructions that not only affect students' mathematical abilities but also strengthen students' affective aspects. This research explores students' geometry self-efficacy when learning to solve three-dimensional geometry problems through the 5E Instructional Model intervention. A grounded theory design was used to reveal the aims of this research. Participants in this research were one mathematics teacher and 22 students (12 girls and 10 boys) in class VIII at a state Junior High School in Indramayu Regency, Indonesia. The research involved the qualitative analysis of gathered data obtained through observation, questionnaires, interviews, and documentation, employing grounded theory analysis techniques, including open coding, axial coding, and selective coding. The findings revealed that students with high self-efficacy in geometry display confidence in describing and calculating the surface area and volume of three-dimensional geometric objects. Those with moderate self-efficacy in geometry are self-assured in addressing straightforward assignments but may need more confidence in tackling more complex tasks. Conversely, students with low self-efficacy in geometry tend to need more confidence and are prone to giving up easily. Therefore, this research emphasizes that the geometry self-efficacy level can influence how students act and complete 3D geometry tasks given by teachers in learning, especially 3D geometry learning.

Corresponding Author:

Sudirman,
Department of Mathematics Education,
Universitas Terbuka
Jl. Cabe Raya, Pondok Cabe, Pamulang, Tangerang Selatan, Banten 15437, Indonesia.
Email: sudirman.official@ecampus.ut.ac.id

How to Cite:

Sudirman, S., García-García, J., Rodríguez-Nieto, C. A., & Son, A. L. (2024). Exploring junior high school students' geometry self-efficacy in solving 3D geometry problems through 5E instructional model intervention: A grounded theory study. *Infinity*, *13*(1), 215-232.

1. INTRODUCTION

Geometry is an important subject that can be used in various fields of science (Herbst et al., 2017), such as making maps, making models, architecture, gardening, artists, builders, designers, bricklayers, and machinists, all of whom use geometry (Rodríguez-Nieto et al., 2023; Sunzuma et al., 2013). In mathematics learning, geometry is a natural forum for developing students' reasoning and skills (Yorulmaz & Altıner, 2021). However, in reality, when studying geometry, students encounter many difficulties, and one of these difficulties is related to students' confidence in answering mathematical problems (Putri & Prabawanto, 2019). This happens because teachers often ignore aspects of student self-efficacy in supporting student learning success (Cantürk-Günhan & Baser, 2007; Ünlü et al., 2010).

Many teachers need to pay more serious attention to the affective aspects of student self-efficacy (Siegle & McCoach, 2007). Most teachers focus more on cognitive aspects or achieving mastery of specific material (Heyder et al., 2020). As a result, many students are discouraged and have poor self-efficacy, making them unable to complete assignments well (Simms, 2016). Therefore, in the context of assigning geometry material, teachers must be able to pay attention to aspects of students' geometry self-efficacy because geometry self-efficacy can influence the geometry learning process (Yorulmaz & Altıner, 2021). Geometry self-efficacy can also influence learning outcomes in other materials (Erkek & Işiksal-Bostan, 2015). The self-efficacy possessed by students will enable students to be able to study geometry and have a positive attitude when studying geometry (Yorulmaz & Altıner, 2021). A positive attitude plays a vital role in student success because there is a positive relationship between attitude and student achievement in learning geometry (Yorulmaz & Altıner, 2021). If students' geometry self-efficacy is good, they will be enthusiastic when studying geometry, which can influence their mastery of geometry material concepts (Isiksal & Askar, 2005; Kandil & Işıksal-Bostan, 2019).

Another study examining geometry self-efficacy, namely Yorulmaz and Altıner (2021), concluded that geometry self-efficacy positively and significantly correlates with attitudes towards geometry. In addition to the aforementioned findings, Sudihartinih et al. (2022) present research results that establish a correlation between self-efficacy, gender, and the level of geometric thinking. Furthermore, Ramlan (2016) contributes additional insights, determining that the Van Hiele learning approach impacts geometric reasoning skills in students with high geometry self-efficacy. Notably, the research also concluded that neither the Van Hiele learning approach nor conventional learning models exerted a significant influence on geometric reasoning skills in students with low self-efficacy (Ramlan, 2016).

Based on these studies, there has been research that uses learning models to increase students' geometry self-efficacy but does not emphasize specific learning model interventions. Therefore, this research aims to explore students' geometry self-efficacy in the context of solving three-dimensional geometry problems by implementing the 5E Instructional Model intervention.

2. METHOD

2.1. Design

A grounded theory design was used in this research because the researcher wanted to gain a deeper understanding of Junior High School students' geometry self-efficacy in solving three-dimensional geometry problems through the 5E Instructional Model intervention. This choice aligns with the nature of grounded theory methodology, where the emphasis is placed on deriving a theory from the collected data, as opposed to shaping data to fit a preconceived theory (Charmaz, 2014).

Furthermore, the application of a grounded theory design is well-suited for this study, aligning with the methodology endorsed by Kamasak et al. (2017). Grounded theory, as described by these authors, is a research method designed to uncover latent theories embedded within systematically collected and analyzed data. The stages of qualitative research using the grounded theory method occur sequentially, starting with the researcher's observation. Simultaneously, data is gathered, organized, and synthesized into a cohesive theory derived directly from the observed phenomena (Charmaz, 2014).

2.2. Participants

Participants in this study consisted of mathematics teachers and Junior High School students at a public school in Indramayu Regency, Indonesia. A total of 22 students, consisting of 12 female and 10 male students, voluntarily agreed to take part in learning using the 5E Instructional Model. One mathematics teacher and three students agreed to be interviewed for more in-depth information. The three students who were subjects were 14-year-old female students. The researchers also selected three students based on their questionnaire results, which included high, medium, and low categories in self-efficacy.

2.3. Data collection

The instruments employed in this research encompassed a combination of observation, questionnaire, interview, and documentation techniques. Observation is used to observe students' self-efficacy geometry during the learning process with the 5E Instructional model. The questionnaire in this research was conducted to determine students' geometry self-efficacy in studying three-dimensional geometry using the 5E Instructional model. To create this questionnaire, researchers took Bandura's theory, which divides dimensions into three, namely (a) magnitude, which is related to the level of task difficulty; (b) generality, which relates to a person's mastery in carrying out a task and (c) strength which relates to the level of strength or weakness of a person's beliefs about their abilities (Bandura, 1977). In this research, interviews were conducted to deepen information from the results of observations and questionnaires. Interviews were conducted with one teacher and three students in a semi-structured manner.

2.4. Data analysis

During the learning process, the researcher made observations of students and made notes related to student activities. At the end of learning with the 5E Instructional Model, students are given a 3D geometry test and a student geometry self-efficacy questionnaire. After the data from the test results and questionnaires were analyzed descriptively, the researchers conducted interviews with teachers and students with high, medium, and low levels of self-efficacy. Next, data obtained from observation notes and interviews were analyzed using three stages, namely open coding, axial coding, and selective coding. The process can be seen in Figure 1.

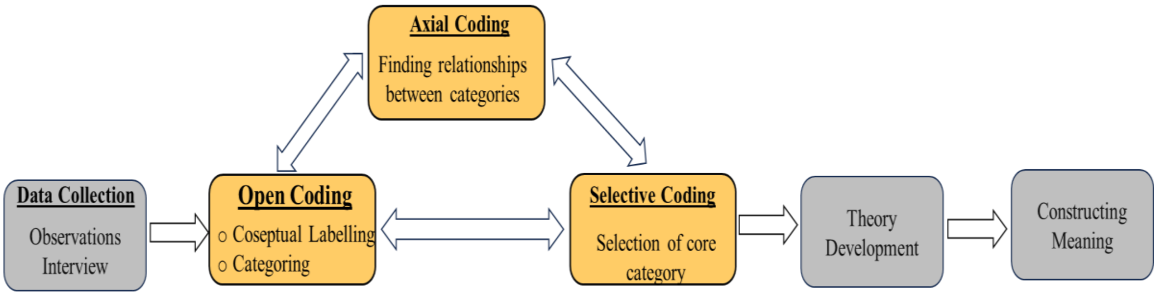

Figure 1. Data analysis

In the open coding stage, texts from interviews with teachers and students were analyzed line by line to identify relevant concepts and categories. After that, at the axial coding stage, the categories that emerged from teacher and student interviews were analyzed for the relationship between the two. In the selective coding stage, categories and their dimensions are considered, compared, and combined to form the final category.

3. RESULT AND DISCUSSION

3.1. Results

3.1.1. 5E Instructional Model Intervention

The 5E Instructional Model stages include the elicit, explore, explain, elaborate, and evaluate phases.

Elicit Phase

In the Elicit phase, the first meeting begins with the teacher motivating students, providing insight into the material, and activating students' prior knowledge. This aims to ensure that students have self-confidence based on their initial knowledge. Students are actively involved in listening, discussing, and answering teacher questions. Each student gave various answers, showing comfort and enthusiasm in studying three-dimensional geometry material. However, the online learning conditions presented challenges at the third meeting, with students responding less actively and many needing to respond to the teacher's questions.

Explore Phase

In the Explore phase, the first meeting involves students working on questions individually related to describing and naming corner points of geometric shapes. The majority of students were able to answer correctly. At the second meeting, students read books and described spatial nets, with most students being able to answer correctly. At the third meeting, students were asked to calculate the volume and surface area of spatial shapes, but only a few submitted answers, indicating challenges in online learning.

Explain Phase

In the explaining stages of the first and second meetings, groups work together to solve questions and present their answers. Discussions and questions and answers went smoothly. However, by the third meeting, most students had only submitted a limited number of presentation videos, indicating a decreasing level of engagement in online learning.

Elaborate Phase

At the elaboration stage, the teacher provides new problems to be worked on individually in the first and second meetings. Most students were able to answer correctly, although there were some mistakes. At the third meeting, questions were given online, with few students submitting answers.

Evaluate Phase

At the evaluation stage, the first and second meetings involve questions to review and evaluate student understanding. Students showed involvement and enthusiasm, but by the third meeting, student responses could have been improved, perhaps due to online learning. In general, the class showed a decrease in self-efficacy in learning three-dimensional geometry in an online context.

3.1.2. Geometry Self-efficacy (GSE) Questionnaire Results

In this study, the Geometry Self-Efficacy (GSE) questionnaire was adapted from the version developed by Cantürk-Günhan and Baser (2007). The questionnaire comprised 55 statements presented in a Likert scale format with five response options (1-Strongly Disagree, 2-Disagree, 3-Slightly Agree, 4-Agree, 5-Agree). A high score on this scale indicates a heightened Geometry Self-Efficacy (GSE) in participants. This scale has three sub-dimensions: geometry self-efficacy (GSE) in representing geometric objects, student self-efficacy in constructing 3D geometric nets, student self-efficacy in determining spatial structure, and student self-efficacy in determining surface area and 3D geometric volume. Twenty-two students participated in filling out the student geometry self-efficacy questionnaire after learning. Data was obtained, based on the questionnaire results, as in Table 1.

Table 1. Geometry self-efficacy

Indicator	GSE High	GSE Medium	GSE Low	Total
GSE in representing 3D geometric objects	8	12	2	22
GSE in constructing 3D geometric meshes	6	12	6	22
GSE determines the spatial structure	4	9	9	22
GSE in determining the surface area and volume of 3D geometry	12	7	3	22

Based on Table 1, eight students are in the high category in their ability to represent geometric objects. Meanwhile, twelve students are in the medium category, and two are in the low category. For the indicator of ability to build 3D geometric nets, there are six students in the high category, twelve students in the medium category, and six students in the low category. Furthermore, in terms of determining spatial structure, there are four students in the high category, nine in the medium category, and nine in the low category. Apart from that, in determining the surface area and volume of 3D geometry, there are twelve students in the high category, seven in the medium category, and three in the low category.

After the results of the questionnaire analysis, the researcher obtained three student subjects who had a high self-efficacy predicate for student 1, symbolized (S1), a moderate self-efficacy predicate for student 2, symbolized (S2), and a low self-efficacy predicate for student 3, symbolized (S3) (see Table 2).

Table 2. Taking research subjects

No.	Student	Score	Predicate	Code
1	YI	80	High	S1
2	DA	59	Medium	S2
3	RI	40	Low	S3

After obtaining three student samples, the researcher arranged a meeting schedule with the three samples outside the school for in-depth interviews. The researchers conducted in-depth interviews outside of school to make students feel comfortable so that they could get the complete data they needed. Researchers conducted in-depth interviews to strengthen the truth of the data obtained from observations and questionnaire results. Apart from that, as a comparison of the data obtained by researchers using different techniques. In the interview technique, the researcher determined that the sources were the mathematics teacher and three students from the results of the questionnaire analysis.

3.1.3. Analysis of Teacher Interview Results

Based on the evaluation of the interview results, the teachers interviewed paid particular attention to student self-efficacy before the teaching and learning process began. This is because teachers believe that the level of student self-efficacy is essential and can influence student learning outcomes, especially in the context of geometry material.

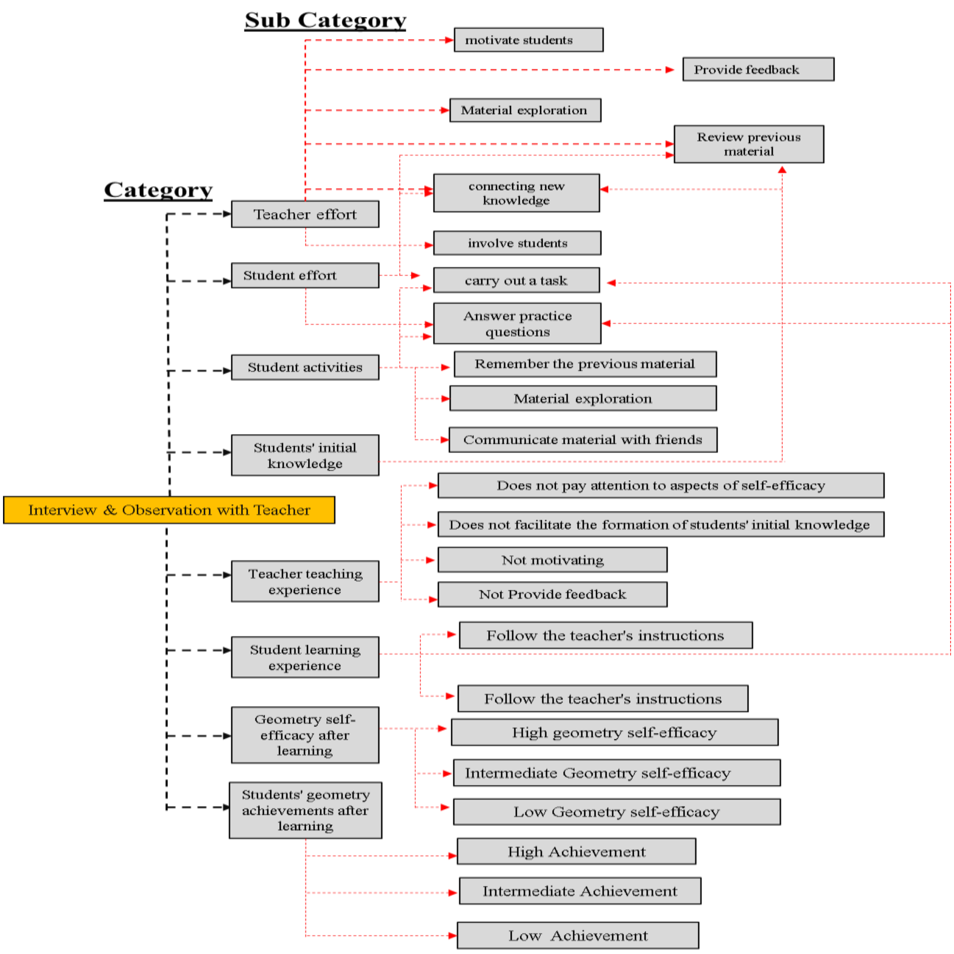

Figure 2. Open coding teacher interview results

Based on Figure 2, referring to the teacher's effort code, the subcategories formed involve providing motivational feedback, reviewing previous material, connecting old material with new material, and involving students in material construction. This teacher's efforts show that there are activities to build student self-efficacy. Motivating by teachers becomes a source of verbal persuasion that increases students' confidence levels. Additionally, inviting students to recall previous material will be a source of confidence for students in their abilities. Another thing is that involving students in constructing new material in the learning process will help students form interactive learning experiences, which will become a source of student self-efficacy.

The results of teacher interviews also show that the success of teachers' efforts depends on students' initiative and activities. Therefore, students' efforts, activities, and prior knowledge become separate codes in this open coding. For example, some students have no previous knowledge of activities to remember previous material, while others need to remember the material. Similar things happen in answering practice questions, exploring material, discussing with friends, and carrying out assignments from the teacher, where some students are very active in following the teacher's instructions. In contrast, others do not carry them out.

In the code analysis of teachers' teaching experiences, most teachers do not focus enough on aspects of student self-efficacy. In addition, they do not actively facilitate the formation of students' prior knowledge, provide insufficient motivational encouragement, or provide inadequate feedback. Teaching methods need to be improved to help the development of students' understanding and enthusiasm for learning in the classroom. Therefore, it is necessary to increase attention to these elements in teaching strategies to improve the quality of learning and student learning outcomes. This could include additional training for teachers, the development of more effective motivation strategies, and implementing more targeted and constructive feedback practices. Thus, teachers' teaching experience can more effectively stimulate students' optimal knowledge and learning motivation development.

Furthermore, based on the analysis of interviews with teachers, the level of self-efficacy and achievement of geometry material was identified as a separate category. In this category, subcategories are formed as a distribution of student self-efficacy, which can be divided into high, medium, and low. This means that teachers observe variations in students' self-confidence regarding their ability to understand and master geometry material. In addition, through students' test results in solving 3D geometry problems, their achievements can be categorized into three levels, namely students with high, medium, and low achievements. This provides a concrete picture of how students can apply the 3D geometry concepts taught in learning.

Further analysis of the distribution of levels of self-efficacy and achievement in geometry material can provide deeper insight into the relationship between students' self-efficacy and their learning outcomes in the context of 3D geometry. For example, specific patterns or trends may be discovered that can help teachers identify more effective learning strategies based on students' levels of self-efficacy or achievement. Thus, this understanding can be the basis for developing a more focused teaching approach and supporting students' success in understanding 3D geometry material.

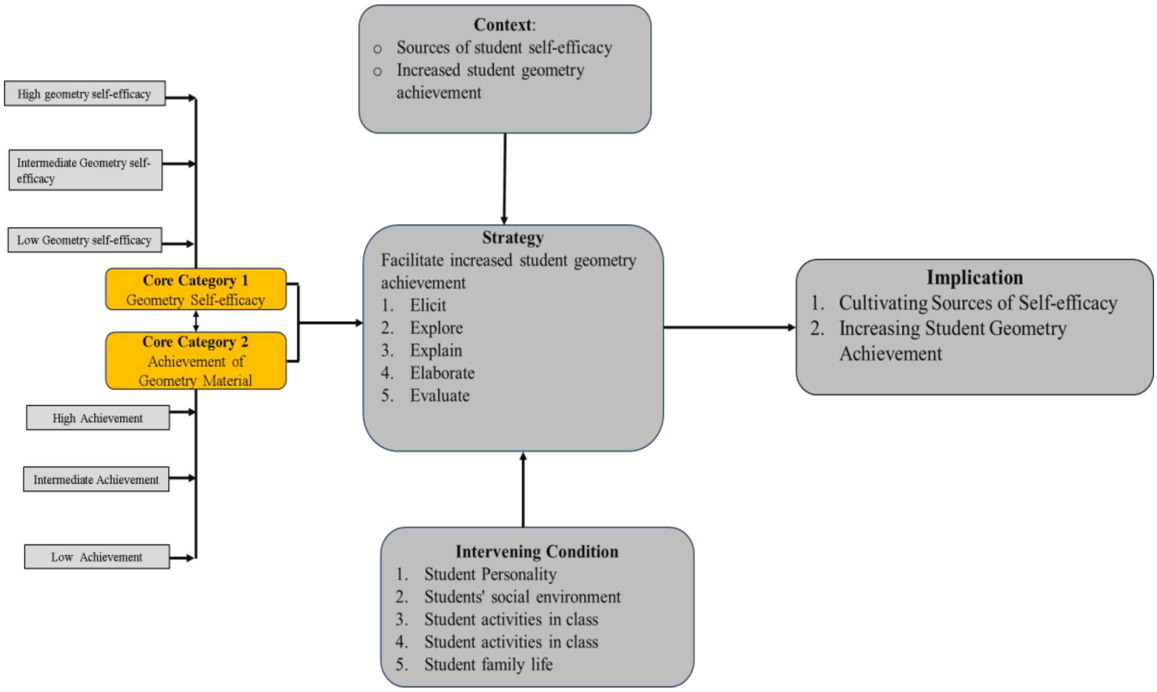

Figure 3. Axial coding teacher interview

Based on Figure 3, the axial coding that emerges is students' geometry self-confidence and achievement of geometry material. The main categories of geometric self-efficacy are divided into three levels: high, medium, and low. Meanwhile, in the student achievement category in geometry material, there are three achievement levels: high, medium, and low. To achieve the core category, there is a context aspect in the form of a source of self-confidence and increasing students' geometric achievements. Teachers also use the 5E instructional model learning strategy, which involves the elicit, explore, explain, elaborate, and evaluate phases. To increase students' self-confidence and geometric achievement, there are conditions beyond the teacher's control, such as students' personalities, social environment, and initial abilities. Therefore, to strengthen students' increased self-efficacy and achievement of geometry, it is necessary to consider these external factors in designing learning strategies.

In the 5E instructional model, the goal of the elicit phase is to help students activate their sources of self-efficacy, such as personal experience and verbal persuasion. Apart from that, in the elicit phase, students can also activate their initial abilities. The explore phase aims to grow confidence through student interaction and exploration of the lesson material. Therefore, the explore phase also plays a vital role in activating students' sources of self-efficacy and helping them build new knowledge. After the exploration phase, students explain and communicate the results of the exploration process to their friends. This helps students gain confidence in conveying their thoughts and improves their interpersonal communication skills. In addition, in the elaborate and evaluation phases, students can measure the extent to which the knowledge gained can be applied to solve their daily problems, deepen their understanding, and evaluate their progress in more depth. This process not only contributes to students' academic development but also to the development of their problem-solving skills.

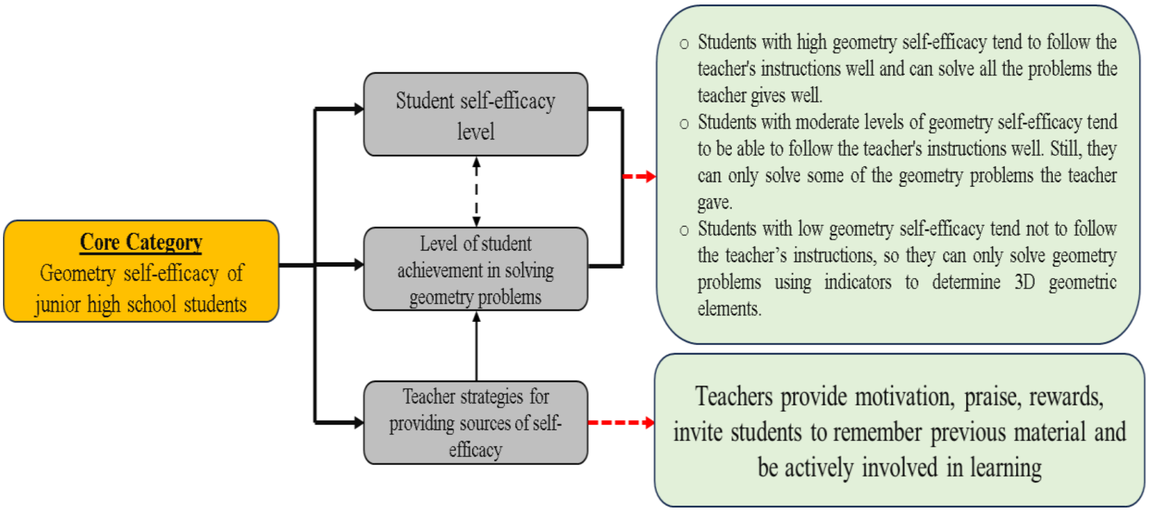

Figure 4. Selective coding teacher interviews

Based on Figure 4, the selective coding analysis found that coding attempts to increase students' self-confidence in learning. Before the teaching and learning process begins, the teacher provides persuasive motivation to students from the first meeting to the fifth meeting. At the first meeting, the teacher invites students to review the previous material, which is essential for building confidence during learning. During the learning process, the teacher invites students to explore the problem context of the teaching materials that have been prepared. This exploration aims to help students understand geometry through interaction with peers. After exploring, students are asked to discuss and communicate with the teacher and their peers. The process of exploration and explanation plays a vital role in helping students gain direct experience through natural interactions.

Apart from that, in the strategy aspect, students with a high level of geometric self-confidence tend to follow the teacher's instructions well and solve all the problems given. Students with moderate confidence in geometry can follow the teacher's instructions but only solve some geometry problems. Students with low levels of geometry self-efficacy tend to avoid following teacher instructions, so they can only solve geometry problems based on indicators of determining 3D geometric elements. Increasing students' self-confidence in the context of geometry is expected to enrich their overall learning experience and encourage active participation in the learning process.

3.1.4. Analysis of Student Interview Results

Figure 5 shows that three students at high, middle, and low levels, it can be seen that there is open coding related to previous knowledge. These codes include student understanding, level of forgetting, need for additional learning, and the extent to which students remember the material. The process of activating previous knowledge seems closely related to students' confidence level in facing instructions from the teacher. Students who still remember the previous material well are better prepared to understand the lesson, while students who need help recalling the material seem to be trying hard.

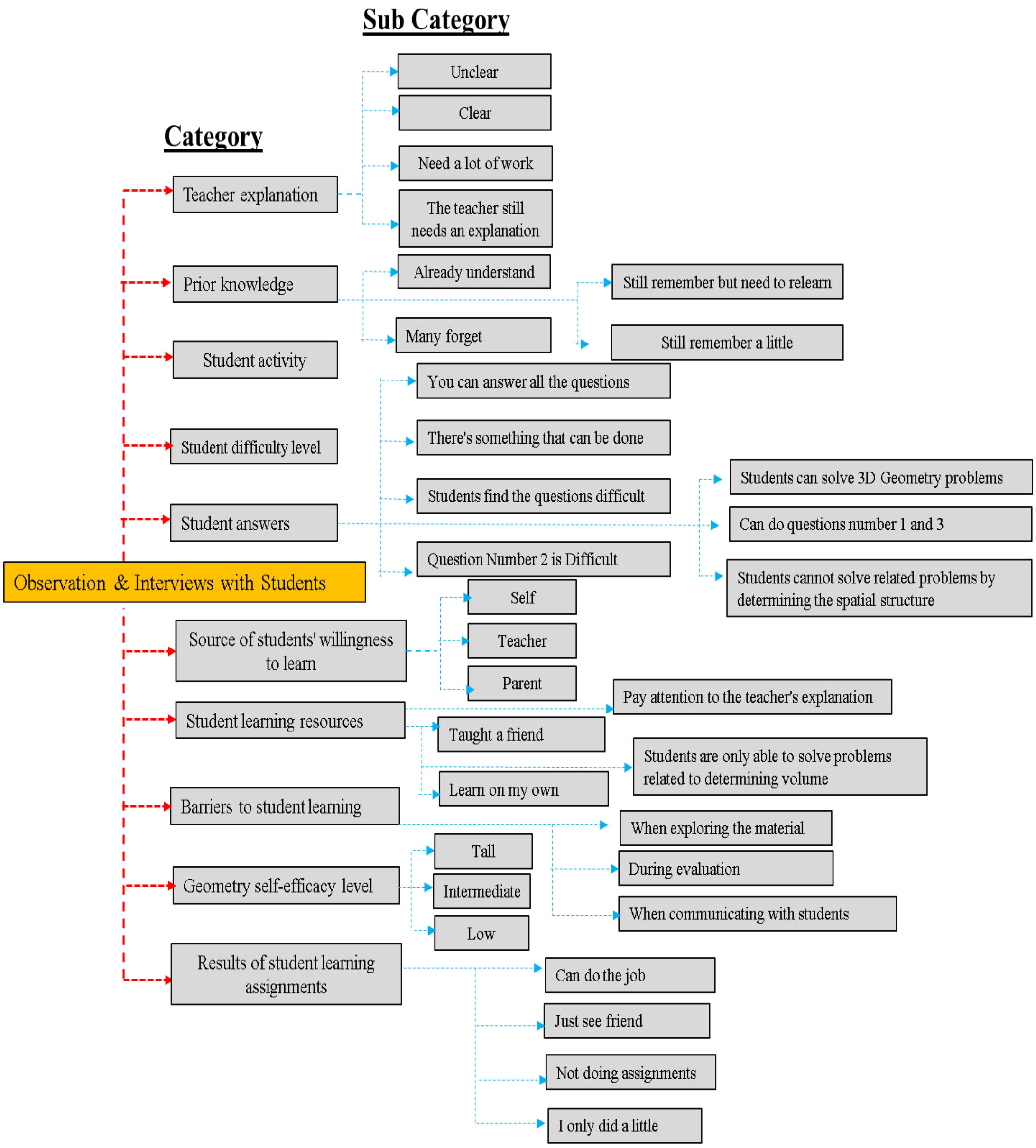

Figure 5. Open coding student interviews

In the context of students' answers, most of them were able to solve questions number 1 and 3, but there were difficulties with questions number 2, 4, and 5. For example, question number 2 was related to constructing 3D geometric nets; question number 4 concerned structure. Spatial, and question number 5 requires determining the volume of 3D geometry. Even though some students could answer all the questions correctly, most could only answer some of them, while some faced difficulties on several questions that were considered problematic.

In the context of learning resources and barriers, most students tend to learn only when in the classroom, relying on direct explanations from the teacher. Some students consider the teacher's explanation inadequate, so they prefer to study with colleagues who understand more or even study independently before listening to the teacher's explanation. From here, we can see variations in student learning styles. Learning obstacles include the perception that the exploration process is complex because it requires prior understanding, and some students face difficulties conveying the results of their exploration to their peers.

When we look at the results of their assignments, several students can complete the assignments well, while others only see the work of their peers, and some still need to complete the assignments the teacher gave. This variation shows differences in students' abilities to respond to and complete learning tasks.

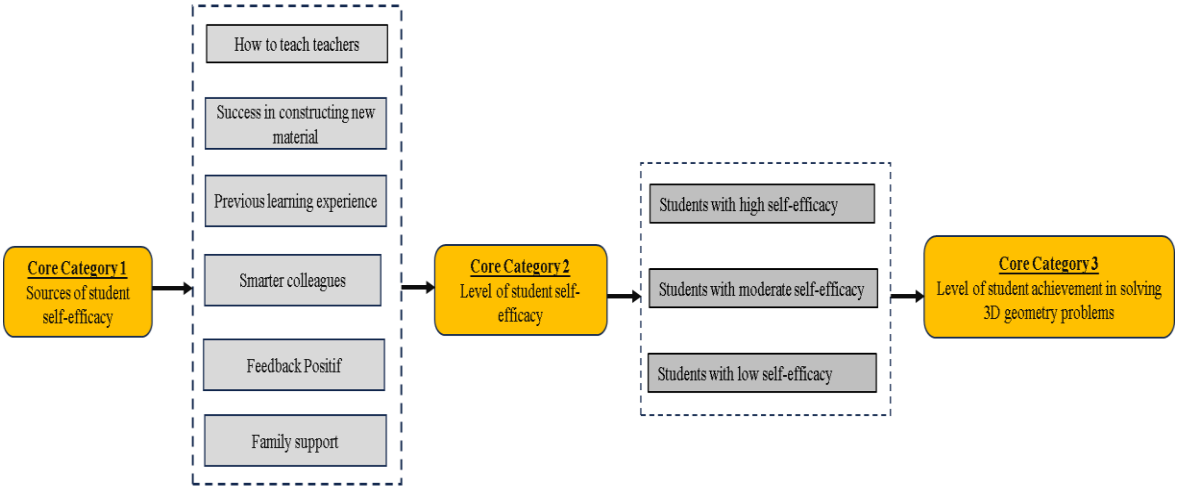

Figure 6. Axial coding student interviews

Based on Figure 6, axial coding from core category 1 is the source of self-efficacy. High, medium, and low students' self-efficacy regarding their ability to succeed in academic tasks and other activities can be influenced by various sources. The following are several sources of student self-efficacy found in this research, namely (1) previous learning experiences; (2) more brilliant friends; (3) how the teacher teaches; (4) feedback from the teacher; (5) student success in completing teacher assignments; (6) family support.

Almost all students stated that previous learning experiences influenced their confidence in succeeding in subsequent learning. Negative experiences in previous meetings also have an impact on students' levels of confidence. Apart from previous learning experiences, observing others completing assignments can increase a student's confidence. Students with a record of success can be role models because they can feel motivated and believe they can achieve similar success.

Other sources of self-efficacy include feedback from teachers, peers, or parents, which can strengthen students' self-confidence. Recognition of their efforts and achievements can increase their level of self-efficacy. Therefore, in the teaching process, teachers must provide motivation and feedback at each stage in the 5E Instructional Model. At the beginning of learning, the teacher can provide an introduction by inviting students to review material from previous meetings to build students' confidence in previous experiences. At the beginning of learning, teachers can also provide motivation and explain the importance of learning new material. In the core part of learning, teachers must be able to provide meaning so that students can construct their knowledge well. At the end of the lesson, the teacher can provide feedback and reinforcement to ensure students' success in understanding geometry material.

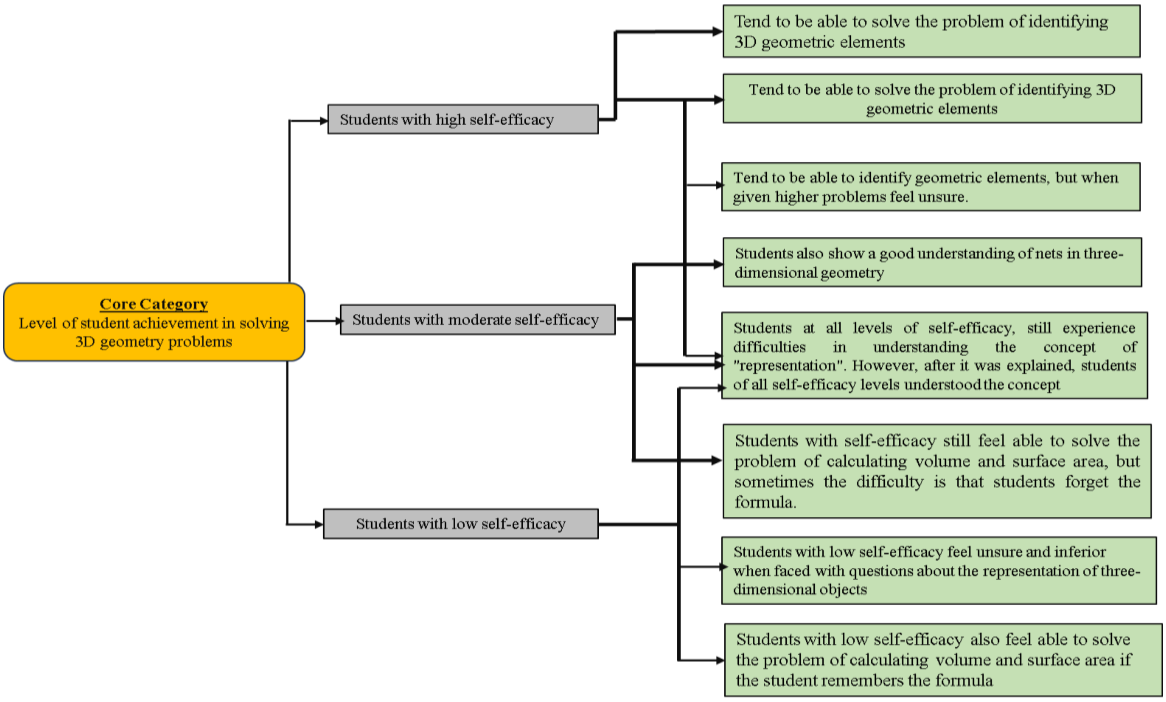

Figure 7. Selective Coding Student Interviews

Figure 7 shows that students with a high level of self-efficacy in studying three-dimensional geometry tend to feel able to understand the material well so that they do not experience difficulties in understanding the concept. In addition, students with high self-efficacy also feel confident in answering questions, allowing them to complete the assignments the teacher gave them. On the other hand, students with moderate self-efficacy feel that they can still master three-dimensional geometry if the questions are relatively straightforward. However, their self-confidence declines when faced with questions that are considered problematic. On the other hand, students with low self-efficacy have difficulty learning three-dimensional geometry because they need help understanding the material.

Research also shows that students with high, medium, and low self-efficacy initially did not understand the concept of the word “representation”. However, after it was explained, they managed to understand it. These three categories of students can understand nets and name the nets correctly. Students with high self-efficacy can solve three-dimensional object representation problems because they understand three-dimensional geometry material well. When facing three-dimensional object representation problems, students with self-efficacy feel confident if the problem is easy but feel less confident if the problem is complex. On the other hand, students with low self-efficacy feel hesitant when answering questions about three-dimensional objects' representation because they need help understanding three-dimensional geometry material. Therefore, students' self-confidence is related to a good understanding of three-dimensional geometry material and the perception that the questions given by the teacher are pretty easy for them.

Research shows that students with high, medium, and low self-efficacy struggle to remember formulas but realize that remembering formulas needs to be done repeatedly. Interviews with the three students showed that they preferred memorizing geometric formulas rather than understanding the concepts behind them. Therefore, it is recommended that teachers use learning methods that emphasize understanding concepts rather than just memorizing formulas to make it easier for students to remember and remember easily. Students with high self-efficacy feel confident they can solve problems regarding volume and surface area. In contrast, students with moderate self-efficacy feel capable of solving these problems but sometimes experience difficulties because they need to remember the formula. Students with low self-efficacy also feel capable of solving problems regarding volume and surface area if they remember the procedure. Therefore, it can be concluded that students' self-confidence, whether high, medium, or low, is related to their ability to calculate volume and surface area, only that they have difficulty remembering the formula.

3.2. Discussion

The research results show that students with a high level of self-efficacy in solving 3D geometry problems tend to have a good understanding of the material, so they can easily understand three-dimensional geometry concepts. In addition, students with high levels of self-efficacy feel confident in answering questions, enabling them to successfully complete assignments given by the teacher. On the other hand, students with medium self-efficacy feel convinced that they can master three-dimensional geometry if the questions presented are relatively straightforward. However, students' self-confidence levels decrease if the questions are considered problematic. Meanwhile, students with low levels of self-efficacy need help understanding three-dimensional geometry material, so they find it challenging to learn it.

The results of this research are supported by several theories that state that confidence is the core of success, both personally and professionally; believing in one's abilities is very important to complete existing tasks in any situation so that you can achieve what you want (Sharma & Nasa, 2014). So, it can be interpreted that belief in one's abilities reflects the belief that one can complete the various tasks given, which can be crucial in achieving success. This perspective aligns with the view of Bandura (1977), who describes self-efficacy as an individual's belief in their ability to complete tasks to achieve specific results.

This research reveals that learning to help students develop self-efficacy is essential. One lesson that can grow students' self-efficacy is the 5E Instructional Model. However, many teachers ignore aspects of student self-efficacy. The results of this research are supported by previous research, namely the results of research by Zee and Koomen (2016), which confirms that educators often ignore the importance of student self-efficacy in the learning process. This condition arises due to students' lack of active response during the learning process. Apart from that, many teachers tend to only focus on evaluating student learning outcomes or place too much emphasis on the material to be tested, thereby ignoring essential aspects of the learning process, including affective elements and developing students' self-ability (Arslan & Işıksal-Bostan, 2016; Deringöl, 2020; Özdemir et al., 2021; Yildiz et al., 2019; Zuya et al., 2016). Understanding these aspects holistically can provide a more complete picture of students' progress and potential in facing learning challenges.

The importance of learning facilitates student self-efficacy because many students feel hopeless and have poor self-efficacy, making them unable to complete mathematics assignments well (Simms, 2016) and vice versa. Students with good self-efficacy have better mathematics learning achievement (Ozkal, 2019). In addition, the provision of feedback and emotional support by teachers significantly impacts students' self-efficacy (Skaalvik et al., 2015). Therefore, teachers must be warm, friendly, respectful, and empathetic in learning, fostering student self-efficacy (Hong et al., 2011; Skaalvik et al., 2015; Thornberg et al., 2017). Theoretically, when teachers offer verbal reinforcement through motivation, constructive feedback, and positive remarks to students, they contribute to the establishment of a self-efficacy source known as "verbal persuasion" (Bandura, 1977).

In the context of presenting 3D geometric objects and building 3D geometric nets, it was found that students with high, medium, and low self-efficacy were not familiar with the meaning of the word "present." Students with high, medium, and low self-efficacy tend to be able to build 3D nets and name the nets correctly. Students with high self-efficacy generally feel confident solving three-dimensional object representation problems because they believe they understand three-dimensional geometry material well. Students with moderate self-efficacy may be able to handle three-dimensional object representation problems, especially those considered easy. On the other hand, students with low self-efficacy tend to be less confident when answering questions regarding the representation of three-dimensional objects because they feel they need to understand three-dimensional geometry material fully.

Furthermore, in determining the surface area and volume of 3D geometry, students with high, medium, and low self-efficacy need help remembering the formula. However, students realize that placing the formula requires repeated practice. Students with high self-efficacy can solve problems calculating volume and surface area well. In contrast, students with moderate self-efficacy can handle these problems but sometimes need help understanding the meaning of the solution. On the other hand, students with low self-efficacy tend to be unable to calculate the surface area and volume of 3D geometry because they need help remembering the required formulas.

The findings of this research align with the results of a study by Kandil and Işıksal-Bostan (2019), which shows that implementing a student activity-based teaching approach significantly positively impacts students' geometry learning achievement. In addition, Ramlan (2016) concluded that using the van Hiele learning model affected the geometric reasoning skills of students with high self-efficacy but did not significantly impact students with low self-efficacy. Furthermore, Alghadari et al. (2020) concluded that there is a relationship between mathematics self-efficacy and geometric problem-solving abilities. Research by Faradilla et al. (2022) found a significant positive relationship between students' self-efficacy and mathematics knowledge in three dimensions.

4. CONCLUSION

Based on the findings and discussion, geometry self-efficacy is one of the factors that can support students' success in studying geometry material. The 5E Instructional Model emerges as a potent learning design facilitating the development of student geometry self-efficacy, with stages such as elicit, explore, explain, and elaborate effectively delving into the roots of this self-efficacy. Sources of self-efficacy, such as own experiences and vicarious experiences, can be grown through interventions in the elicit and explore stages. In contrast, sources of self-efficacy in the form of verbal persuasion can be grown through interventions in the explain and elaborate phases.

Furthermore, after the researchers carried out the intervention using the 5E Instructional model, it showed that (a) students who have high self-efficacy tend to be able to solve 3D geometry problems because students feel they can understand the material well and do not find it challenging to learn three-dimensional geometry. In addition, students with high self-efficacy feel confident in answering questions so they can complete the questions given by the teacher. Students with high self-efficacy feel capable of solving problems regarding the representation of three-dimensional objects because they feel they understand three-dimensional geometry well. Students with high self-efficacy can solve problems in calculating volume and surface area. (b) Students who have moderate self-efficacy tend to be able to solve three-dimensional geometry problems only on relatively straightforward problems. Students with moderate self-efficacy can solve problems regarding the representation of three-dimensional objects if the questions are fairly straightforward. However, if the questions are classified as complex, students feel less confident in solving the problems. Students with moderate self-efficacy feel capable of solving problems calculating volume and surface area but sometimes need help remembering. (c) Students with low self-efficacy find it challenging to learn three-dimensional geometry because they need help understanding three-dimensional geometry material. Students with low self-efficacy feel unsure when answering questions about the representation of three-dimensional objects because they need help understanding three-dimensional geometry material. Students with low self-efficacy can also solve problems calculating volume and surface area if they remember the formula.

This research also implies that students' self-efficacy has a vital role because it is one of the factors in improving student learning outcomes, especially in studying 3D geometry material. When students possess a high level of self-efficacy, they demonstrate a profound trust in the effectiveness of their mathematical skills to solve both intra and extra-mathematical problems, establishing meaningful connections with real-life scenarios involving various artifacts. A student who is confident in their ability to grasp three-dimensional geometry not only feels empowered in their mathematical practice but also exhibits the confidence to tackle the problems presented by the teacher. This confidence becomes a driving force in their engagement with mathematical challenges.

REFERENCES

Alghadari, F., Herman, T., & Prabawanto, S. (2020). Factors affecting senior high school students to solve three-dimensional geometry problems. *International Electronic Journal of Mathematics Education*, *15*(3), em0590. https://doi.org/10.29333/iejme/8234

Arslan, O., & Işıksal-Bostan, M. (2016). Turkish prospective middle school mathematics teachers' beliefs and perceived self-efficacy beliefs regarding the use of origami in mathematics education. *Eurasia Journal of Mathematics Science and Technology Education*, *12*(6), 1533-1548. https://doi.org/10.12973/eurasia.2016.1243a

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191-215. https://doi.org/10.1037/0033-295X.84.2.191

Cantürk-Günhan, B., & Baser, N. (2007). The development of self-efficacy scale toward geometry. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*(33), 68-76.

Charmaz, K. (2014). *Constructing grounded theory* (2nd ed.). Sage.

Deringöl, Y. (2020). Middle school students perceptions of their self-efficacy in visual mathematics and geometry: a study of sixth to eighth grade pupils in Istanbul province, Turkey. *Education 3-13*, *48*(8), 1012-1023. https://doi.org/10.1080/03004279.2019.1709527

Erkek, Ö., & Işiksal-Bostan, M. (2015). The role of spatial anxiety, geometry self-efficacy and gender in predicting geometry achievement. *Elementary Education Online*, *14*(1), 164-180.

Faradilla, N., Putra, Z. H., & Noviana, E. (2022). The relationship between self-efficiency and mathematical knowledge of 3-D shapes of fifth grade of elementary school. *Journal of Teaching and Learning in Elementary Education (JTLEE)*, *5*(1), 34-47. https://doi.org/10.33578/jtlee.v5i1.7906

Herbst, P., Fujita, T., Halverscheid, S., & Weiss, M. (2017). *The learning and teaching of geometry in secondary schools: A modeling perspective*. Taylor & Francis. https://doi.org/10.4324/9781315267593

Heyder, A., Weidinger, A. F., Cimpian, A., & Steinmayr, R. (2020). Teachers' belief that math requires innate ability predicts lower intrinsic motivation among low-achieving students. *Learning and Instruction*, *65*, 101220. https://doi.org/10.1016/j.learninstruc.2019.101220

Hong, B. S. S., Shull, P. J., & Haefner, L. A. (2011). Impact of perceptions of faculty on student outcomes of self-efficacy, locus of control, persistence, and commitment. *Journal of College Student Retention: Research, Theory & Practice*, *13*(3), 289-309. https://doi.org/10.2190/CS.13.3.b

Isiksal, M., & Askar, P. (2005). The effect of spreadsheet and dynamic geometry software on the achievement and self-efficacy of 7th-grade students. *Educational Research*, *47*(3), 333-350. https://doi.org/10.1080/00131880500287815

Kamasak, R., Kar, A., Yavuz, M., & Baykut, S. (2017). Qualitative methods in organizational research: An example of grounded theory data analysis. In B. Christiansen & H. C. Chandan (Eds.), *Handbook of research on organizational culture and diversity in the modern workforce* (pp. 23-42). IGI Global. https://doi.org/10.4018/978-1-5225-2250-8.ch002

Kandil, S., & Işıksal-Bostan, M. (2019). Effect of inquiry-based instruction enriched with origami activities on achievement, and self-efficacy in geometry. *International Journal of Mathematical Education in Science and Technology*, *50*(4), 557-576. https://doi.org/10.1080/0020739X.2018.1527407

Özdemir, A., Karaşan, S., & Şahal, M. (2021). An examination of the relationship between secondary school students' abstract thinking skills, self-efficacy perceptions and attitudes towards mathematics. *Participatory Educational Research*, *8*(2), 391-406. https://doi.org/10.17275/per.21.45.8.2

Ozkal, N. (2019). Relationships between self-efficacy beliefs, engagement and academic performance in math lessons. *Cypriot Journal of Educational Sciences*, *14*(2), 190-200. https://doi.org/10.18844/cjes.v14i2.3766

Putri, W. K. H. W., & Prabawanto, S. (2019). The analysis of students' self-efficacy in learning mathematics. *Journal of Physics: Conference Series*, *1157*(3), 032113. https://doi.org/10.1088/1742-6596/1157/3/032113

Ramlan, A. M. (2016). The effect of Van Hiele learning model toward geometric reasoning ability based on self-efficacy of senior high school students. *Journal of mathematics Education*, *1*(2), 62-71. https://doi.org/10.31327/jme.v1i2.54

Rodríguez-Nieto, C. A., Rodríguez-Vásquez, F. M., & Moll, V. F. (2023). Combined use of the extended theory of connections and the onto-semiotic approach to analyze mathematical connections by relating the graphs of f and f'. *Educational Studies in Mathematics*, *114*(1), 63-88. https://doi.org/10.1007/s10649-023-10246-9

Sharma, H. L., & Nasa, G. (2014). Academic self-efficacy: A reliable predictor of educational performances. *British Journal of Education*, *2*(3), 57-64.

Siegle, D., & McCoach, D. B. (2007). Increasing student mathematics self-efficacy through teacher training. *Journal of Advanced Academics*, *18*(2), 278-312. https://doi.org/10.4219/jaa-2007-353

Simms, V. (2016). Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching. *Research in Mathematics Education*, *18*(3), 317-320. https://doi.org/10.1080/14794802.2016.1237374

Skaalvik, E. M., Federici, R. A., & Klassen, R. M. (2015). Mathematics achievement and self-efficacy: Relations with motivation for mathematics. *International Journal of Educational Research*, *72*, 129-136. https://doi.org/10.1016/j.ijer.2015.06.008

Sudihartinih, E., Wahyudin, W., & Prabawanto, S. (2022). Self-efficacy students prospective teachers are reviewed from gender in analytic geometry lectures. In AIP Conference Proceedings. https://doi.org/10.1063/5.0102481

Sunzuma, G., Masocha, M., & Zezekwa, N. (2013). Secondary school students' attitudes towards their learning of geometry: A survey of Bindura urban secondary schools. *Greener Journal of Educational Research*, *3*(8), 402-410. https://doi.org/10.15580/gjer.2013.8.051513614

Thornberg, R., Wänström, L., Hong, J. S., & Espelage, D. L. (2017). Classroom relationship qualities and social-cognitive correlates of defending and passive bystanding in school bullying in Sweden: A multilevel analysis. *Journal of School Psychology*, *63*, 49-62. https://doi.org/10.1016/j.jsp.2017.03.002

Ünlü, M., Avcu, S., & Avcu, R. (2010). The relationship between geometry attitudes and self-efficacy beliefs towards geometry. *Procedia - Social and Behavioral Sciences*, *9*, 1325-1329. https://doi.org/10.1016/j.sbspro.2010.12.328

Yildiz, P., Çiftçi, S. K., & Özdemir, I. E. Y. (2019). Mathematics self-efficacy beliefs and sources of self-efficacy: A descriptive study with two elementary school students. *International Journal of Progressive Education*, *15*(3), 194-206. https://doi.org/10.29329/ijpe.2019.193.14

Yorulmaz, A., & Altıner, E. Ç. (2021). Do geometry self-efficacy and spatial anxiety predict the attitudes towards geometry? *Elementary School Forum (Mimbar Sekolah Dasar)*, *8*(2), 205-216. https://doi.org/10.53400/mimbar-sd.v8i2.35914

Zee, M., & Koomen, H. M. Y. (2016). Teacher self-efficacy and its effects on classroom processes, student academic adjustment, and teacher well-being: A synthesis of 40 years of research. *Review of Educational Research*, *86*(4), 981-1015. https://doi.org/10.3102/0034654315626801

Zuya, H. E., Kwalat, S. K., & Attah, B. G. (2016). Pre-service teachers' mathematics self-efficacy and mathematics teaching self-efficacy. *Journal of Education and Practice*, *7*(14), 93-98.