Swimming as a context for learning number patterns: a study of mathematical connections and anxiety

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Abstract

This study aims to analyze the effectiveness of learning number patterns in the context of swimming and the relationship between mathematical connection skills and the level of mathematical anxiety of junior high school students in learning number patterns in the context of swimming. This study used a one-group pretest-posttest design with a sample size of 40 eighth-grade students in class VIII B at a junior high school in Telukjambe Timur subdistrict. Data were collected through a mathematical connection ability test and a mathematical anxiety questionnaire. Quantitative data analysis used the effect size formula and Pearson's correlation test to examine the relationship between variables. The results showed that learning number patterns with a swimming context was effective in improving mathematical connection skills and reducing anxiety levels, and there was a significant relationship. This indicates a very strong and positive relationship, where the effectiveness of learning with a swimming context in building mathematical connections is directly proportional to the affective condition of students. Strengthening mathematical connections through a swimming context can be a way to manage students' mathematical anxiety.

Keywords: mathematical anxiety; mathematical connection skills; number patterns; realistic mathematics education (RME); swimming context.

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INTRODUCTION

Mathematics is a fundamental discipline that equips students with logical and systematic thinking skills. The material in mathematics learning is integrated and continuous so that the topics are interrelated and progressive. There are prerequisite topics or concepts that serve as the basis for understanding and mastering the mathematical topics or concepts that will be studied later. Thus, mathematical connections play an important role in mathematics learning, especially in building new understanding based on prior knowledge by connecting interactions between previously learned mathematical topics/ideas. The ability to make connections helps students see mathematics as an interconnected whole (Rodríguez-Nieto et al., 2025).

Low mathematical connection skills remain a major challenge in mathematics education in Indonesia. Fathiyyah et al., (2023) concluded that students' mathematical connection skills are low. Many

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students find it difficult to transform real-world situations into mathematical models, one example being number patterns. Number patterns are considered difficult by students (Yahya et al., 2023). This difficulty hinders students from achieving the learning objectives of number patterns.

These obstacles are not only cognitive in nature, but are also influenced by affective aspects, particularly anxiety when learning mathematics. Anxiety in mathematics learning is one of the obstacles to achieving learning objectives (Shishigu et al., 2024). Anxiety is a condition experienced by some people, characterized by unpleasant feelings such as fear, excessive worry, inability to concentrate and remain calm, discomfort, and tension, often arising from feelings about a certain situation, such as when facing dangers (Hadi et al., 2020). Haskins (2024) states that mathematical anxiety in students is triggered by various complex factors, ranging from the negative stigma in society that mathematics is a difficult subject to the internal characteristics of mathematics, which are abstract and theoretical in nature. In addition, external factors such as inappropriate pedagogical approaches, low learning independence, and an excessive focus on achieving high grades also exacerbate students' psychological conditions. Recent studies show that students with high levels of anxiety tend to have difficulties in processing information, making it difficult for them to optimally connect concepts. Muhsana and Diana (2022) state that high levels of learning anxiety can have a negative impact on the learning process of students.

Aisyah and Adirakasiwi (2025) state that meaningful learning that is closely related to the experiences of students has the potential to reduce learning anxiety because students feel more confident and understand the relationship between concepts and real life. Through strong connections, students do not only view mathematics as a collection of isolated formulas, but as a functional tool for solving everyday problems. To overcome this, a learning approach is needed that can connect mathematics with the reality of students through Realistic Mathematics Education (RME). Setiawarni et al., (2019) stated that there is a difference in mathematical connection abilities between students who follow learning with the RME approach and students who do not follow this approach. The use of real-life contexts can help reduce cognitive load and psychological stress for students. The discussion of mathematics material is related to daily activities, so the use of context can help students understand the material (Rahmah et al., 2025). The context of sports can create an atmosphere and environment that supports positive relationships between educators and students (Katsogridakis & Leather, 2024).

Context in mathematics learning can make abstract mathematical concepts easier for students to understand (Sujatha & Vinayakan, 2023). The context of sports has been used by several mathematics education researchers to teach mathematics because it can present abstract mathematical problems in a way that is easy for students to understand (Yansen et al., 2018; Effendi et al., 2019; Effendi et al., 2020; Mutia et al., 2021; Turner et al., 2024; Effendi et al., 2024; Pujiani & Effendi, 2025; Nurlaeli et al., 2025), By using the context of sports in the mathematics learning process, learning will become more meaningful, interesting, and enjoyable. This study uses the context of swimming integrated into number pattern learning tools. The swimming context provides visual representations and physical activities that can help students construct pattern concepts more naturally and enjoyably. With a more familiar and relaxed learning atmosphere through the application of RME, students' mathematical anxiety levels can be reduced (Çopur & Tümkaya, 2024).

The relationship between cognitive and affective aspects is an important focus in this study. Understanding how mathematical connection skills and mathematical anxiety are related is crucial for teachers to determine the appropriate learning interventions to achieve learning objectives. Research that simultaneously integrates mathematical connection abilities and mathematical anxiety in specific and meaningful mathematics learning is still limited. In addition, the application of swimming-based mathematics learning at the junior high school level is still rarely found, even though this context has great potential in representing number patterns concretely and closely related to the lives of students. Therefore, this study needs to be conducted to thoroughly examine the mathematical connection abilities and mathematical anxiety of junior high school students in learning number patterns in the context of swimming. In addition, it is important to determine the effectiveness of applying the swimming context in number pattern learning as an effort to create more contextual, meaningful, and enjoyable mathematics learning, while also improving the quality of learning and reducing student learning anxiety in accordance with the demands of 21st-century learning and the Merdeka Curriculum.

METHODS

This study used a quantitative approach with a quasi-experimental method using a One Group Pretest-Posttest Design (Sugiyono, 2019). This study provided treatment to the sample by integrating the context of swimming into learning number patterns with a swimming context to improve the students' connection skills and reduce their mathematical anxiety levels. The population of this study was eighth-grade students at a junior high school in Telukjambe Timur Subdistrict, and the sample consisted of 40 eighth-grade students from class B, selected using purposive sampling. The sample selection was based on the consideration that the students had acquired the necessary basic material and had varying levels of anxiety. The instruments used in this study consisted of valid and reliable tests and non-tests. The test instrument consisted of five questions assessing mathematical connection skills, which were compiled based on indicators of connections between mathematical topics and connections with everyday life (swimming context). The questionnaire was filled out by checking the boxes for strongly disagree (STS), disagree (TS), agree (S), or strongly agree (SS). The collected questionnaire data were ordinal data, which were then converted into interval data using the successive interval method (MSI). MSI is a process of converting ordinal data into interval data (Ningsih & Dukalang, 2019). in score calculation the higher questionnaire scores indicate lower levels of mathematical anxiety because negatively worded items were reverse-scored. The scoring guidelines can be seen in Table 1.

Table 1. Scoring Guidelines

Alternatif Jawaban	STS	TS	S	SS
Positif	1	2	3	4
rNegatif	4	3	2	1

To determine the effectiveness of applying the swimming context in teaching number patterns, the effect size was calculated using IBM SPSS Statistics with interpretation in Table 2 (Thalheimer & Cook, 2002).

Table 2. Effect Size Interpretation

D	Interpretation
$d \leq 0{,}2$	Low
$0{,}2 < d \leq 0{,}8$	Middle
$d > 8$	High

Data analysis techniques were carried out through prerequisite analysis tests, including the Shapiro-Wilk normality test and linearity test to ensure that the data were normally distributed and had a linear relationship (Souza et al., 2023). The next stage is hypothesis testing to answer the relationship between variables using the Pearson Product Moment Correlation Test. The correlation coefficient (r) value is analyzed to determine the strength and direction of the relationship between mathematical connection abilities and mathematical anxiety among students (Turney, 2024). Interpretation of the correlation values in Table 3.

Table 3. Interpretation of Correlation

Pearson correlation coefficient (*r*) value	Strength	Direction
Greater than .5	Strong	Positive
Between .3 and .5	Moderate	Positive
Between 0 and .3	Weak	Positive
0	None	None
Between 0 and –.3	Weak	Negative
Between –.3 and –.5	Moderate	Negative
Less than –.5	Strong	Negative

RESULTS AND DISCUSSION

This study focuses on analyzing the relationship between the cognitive aspect of mathematical connection skills and the affective aspect, namely mathematical anxiety. Based on the results of data collection from 40 eighth-grade students, a comprehensive picture of the relationship between the two variables in learning number patterns in the context of swimming was obtained. Before applying the swimming context in learning number patterns, students were given a pretest and afterwards a posttest, with the results shown in Table 4.

Table 4. Pre-test and Post-test Results of Mathematical Connection Skills

	Pretest	Postest
Mean	51.75	64.43
Std. Deviation	21.825	5.344

Table 4 shows an improvement in mathematical connections in number ball material, as seen from a higher average post-test score of 12.68. Based on the effect size calculation of 0.7977, the interpretation is middle. Furthermore, Table 5 below shows the results of the normality test for anxiety and mathematical connection data in number pattern learning.

Table 5. Normality Test Results

	Kecemasan Matematis	Koneksi Matematis
Shapiro-Wilk	0.088	0.082

Table 5 shows that the sig. for the variables of mathematical connection and anxiety in learning contextual number patterns is greater than 0.05, which means that the data is normally distributed. Table 6 presents the results of the linearity test.

Table 6. Linearity Test Results

	Significance Value
Mathematical Connection Ability and Mathematics Anxiety	0.999

Based on Table 6 In the linearity test, the resulting number is 0.999, which means that there is a linear relationship between mathematical connection ability and mathematical anxiety among students.

The results of the prerequisite analysis test show that the data is normally distributed and linear. The next test conducted was a correlation test, specifically a product moment correlation test. Ismail and

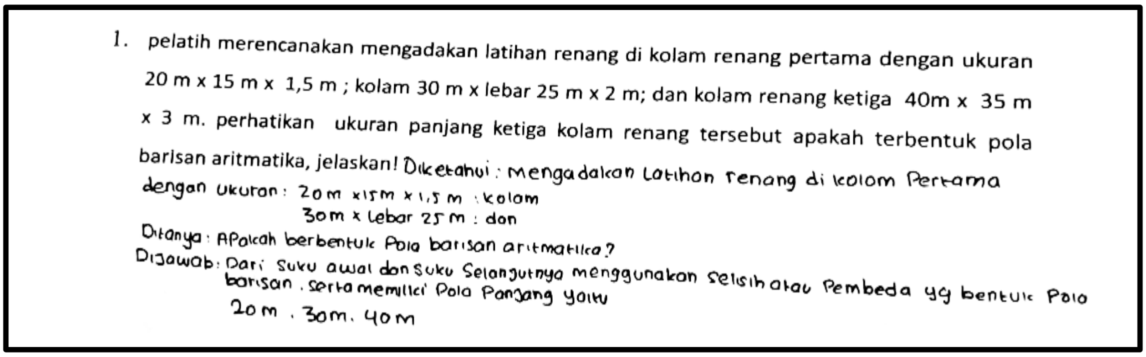
Zulkarnaen (2023) used product moment correlation analysis to identify the degree of linear relationship between two variables that met the assumption of normal distribution. The results of the product moment correlation test are presented in the following Table 7.

Table 7. Correlation Test Results

Variabel	Pearson Correlation	p
Kemampuan Koneksi Matematis – Kecemasan Matematis	0.911	.000

Based on Table 7, the r value is 0.911 with p=0.000. The findings of this study indicate a very strong correlation between mathematical connection skills and mathematical anxiety. This relationship suggests that cognitive and affective dimensions in mathematics learning are closely intertwined rather than operating independently. Considering that higher questionnaire scores reflect lower levels of anxiety, the positive correlation coefficient indicates that students with lower levels of mathematical anxiety tend to demonstrate stronger mathematical connection skills. This means that the lower the mathematical anxiety, the higher the mathematical connection skills, and the higher the mathematical anxiety, the lower the mathematical connection skills of students. In the context of number pattern learning integrated with swimming activities, this very strong relationship indicates that the success of students in building mathematical connections is directly proportional to the management of students' mathematical anxiety. When students are able to connect real-world phenomena such as swimming strokes to the concept of number sequences, they tend to have higher self-confidence. Wulandari and Sunarmi (2020) emphasize that the use of sports activities as a context for mathematics learning not only improves conceptual understanding but also reduces students' anxiety about mathematics lessons. Sari and Zulkarnaen (2022) state that a strong understanding of mathematical concepts is considered a fundamental competency that every student needs to have to ensure success in the mathematics learning process. Successfully making these mathematical connections can effectively reduce mental stress, keeping students' anxiety at a manageable level. Strengthening their ability to make connections can boost their confidence, which ultimately reduces their anxiety when facing complex mathematical problems.

The strong relationship identified in this study implies that efforts to improve students' mathematical connection skills should not focus solely on cognitive instruction strategies. Addressing affective factors particularly anxiety management may be equally important. Instructional designs that integrate real-world contexts, collaborative learning, and guided exploration may simultaneously support conceptual understanding and emotional regulation. Thus, the findings demonstrate that the improvement of mathematical connections is not merely a function of content mastery but is also influenced by students' psychological readiness to engage in mathematical thinking. Anxiety creates psychological pressure that can hinder students' effectiveness in absorbing and understanding mathematical material (Astuti et al., 2025). Students with low anxiety levels tend to have better working memory capacity for reasoning and connecting various mathematical concepts. Conversely, high anxiety often hinders students from seeing the connections between concepts because their minds are focused on the fear of making mistakes. Hadiati et al., (2020) state that the affective domain includes manifestations of student attitudes and behaviors that appear consistently, both in formal interactions during learning and in informal activities in the school environment. This can be seen from the answers of students who have moderate levels of mathematical anxiety and mathematical connection abilities. The students' answers can be seen in Figure 1.



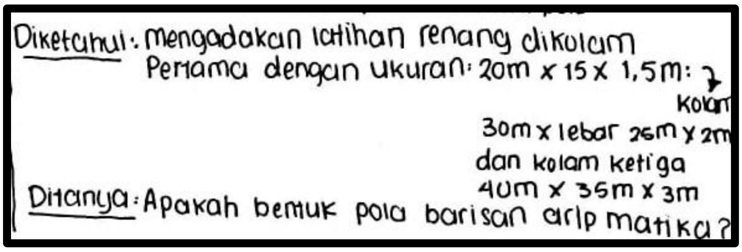
1. pelatih merencanakan mengadakan latihan renang di kolam renang pertama dengan ukuran 20 m x 15 m x 1,5 m ; kolam 30 m x lebar 25 m x 2 m; dan kolam renang ketiga 40m x 35 m x 3 m. perhatikan ukuran panjang ketiga kolam renang tersebut apakah terbentuk pola barisan aritmatika, jelaskan! Diketahui : Mengadakan Latihan renang di kolom Pertama dengan ukuran : 20 m x 15 m x 1,5 m : kolom 30 m x Lebar 25 m : don

Ditanya : Apakah berbentuk Pola barisan aritmatika?

Dijawab : Dari suku awal dan suku selanjutnya menggunakan selisih atau Pembeda yg bentuk Pola barisan . serta memiliki Pola Panjang yaitu 20 m . 30 m . 40 m

Figure 1. Student Responses

Figure 1 shows one of the students' answers to the first question. This question contains the measurements of three pool lengths, and students are asked to determine whether the lengths of the three pools form a number pattern. This student is in the moderate mathematical anxiety and moderate mathematical connection ability categories. Based on their answer, the student was only able to solve the question without providing additional explanations. They tried to solve the question by writing down the known information, the question, and the answer. The student also appeared to have understood the steps for solving contextual story problems. In contrast, research by Hamdani and Nurdin (2020) shows that student scores are still low and not all connection indicators have been met, especially in applying mathematics in everyday life.



Diketahui : Mengadakan latihan renang dikolam Pertama dengan ukuran : 20m x 15 x 1,5m : kolam 30m x lebar 26m x 2m dan kolam ketiga 40m x 35m x 3m

Ditanya : Apakah bentuk pola barisan aritmatika?

Figure 2. Student Responses

Figure 2 shows one of the students' answers to the same question. The student has a moderate level of mathematical anxiety and low mathematical connection skills. Based on the answer, the student was only able to write down what was known and what was asked without solving the problem and providing additional explanations. The student still does not understand the steps to solve contextual word problems. Yuliani and Zaenal (2023) state that affective maturity is the main foundation in strengthening students' mathematical connections. Supported by Fani and Effendi (2021), the emotional condition of students, particularly related to learning anxiety, plays a significant role in the extent to which they are able to relate mathematical theory to different contexts. Therefore, the students' answers in Figure 2 show that mathematical anxiety does indeed affect mathematical connection abilities.

The mathematics learning process in number patterns is systematically designed to develop students' abilities to recognize, predict, and generalize arithmetic and geometric number patterns. At the beginning of the lesson, the teacher relates mathematical concepts to the students' real-life experiences through videos of swimming activities and swimming competitions, thereby stimulating curiosity and increasing students' motivation to learn (Lintuman & Wijaya, 2025). The use of context serves as a bridge between the students' prior knowledge and the mathematical concepts to be learned.

In the core activity, students were divided into heterogeneous groups and given Student

Worksheets containing authentic swimming-related problems, such as training distance, competition time, and swimming ability improvement. Students were guided through the exploration and discovery phase (Pedaste et al., 2015). Through groups, students are guided to identify number patterns, determine the first term, the next term, and find the formula for the nth term in arithmetic and geometric sequences (Latifa et al., 2024). Teachers act as facilitators by guiding discussions, asking provocative questions, and reinforcing concepts when students encounter difficulties.

Students are given the opportunity to present the results of their group discussions in the form of presentations. Presentation and question-and-answer activities enable the exchange of ideas among students and strengthen their understanding and independent thinking (Indrawati, 2017). At this stage, teachers and students analyze and evaluate the problem-solving process, then formulate conclusions together. Each meeting concludes with individual reflection and evaluation through exercises, allowing teachers to continuously monitor students' progress. From a theoretical perspective, this finding can be explained through cognitive–affective interaction frameworks in mathematics learning. Mathematical anxiety affects students' working memory capacity, attention control, and information processing efficiency. When anxiety levels are high, a significant portion of cognitive resources is allocated to managing fear and worry rather than to conceptual reasoning and pattern recognition. Consequently, students may struggle to establish meaningful connections between mathematical concepts. Conversely, when students experience lower anxiety levels, their cognitive resources can be more fully devoted to analyzing patterns, recognizing relationships among representations, and constructing generalizations. This psychological stability facilitates deeper conceptual integration, which is essential for developing mathematical connection skills.

The finding that mathematical anxiety can affect students' mathematical connection abilities contradicts the research by Yuliana et al. (2023), which concluded that mathematical anxiety has a negative impact on students' ability to establish mathematical connections. Nopriana et al. (2024) also stated that students with low anxiety showed more optimal achievement in mathematical connection skills. The study showed that students' mathematical connection skills were not only influenced by affective aspects such as anxiety in learning mathematics. The results of the study indicate that the relationship between math anxiety and mathematical connection skills is not absolute. This means that students still have individual variations even at the same level of math anxiety. This indicates that math anxiety is not the only factor that influences students' mathematical connection skills, but there are also influences from various factors, both internal factors of the students and external factors.

CONCLUSION

This study aimed to examine the effectiveness of integrating a swimming context into the learning of number patterns and to investigate the relationship between mathematical anxiety and students' mathematical connection skills. The findings indicate that the use of a swimming context was associated with a substantial improvement in students' mathematical connection abilities. In addition, a very strong relationship was identified between mathematical anxiety and mathematical connection skills, highlighting the close interplay between cognitive and affective dimensions of mathematics learning. The results suggest that lower levels of mathematical anxiety are associated with stronger abilities to establish meaningful connections among mathematical concepts. By demonstrating the potential of a swimming-based contextual approach, this research offers an alternative instructional design that is engaging, meaningful, and responsive to students' psychological needs. However, the findings should be interpreted with caution due to the limited research design, which involved observations of a single group of participants over time. Future studies involving broader participant populations and more rigorous comparative research designs are recommended to provide stronger evidence and enhance the generalizability of these findings. This study contributes to mathematics learning by providing alternative solutions to improve mathematical connection skills and reduce learning anxiety through the integration of swimming contexts into number pattern learning, making it more contextual, interesting, and enjoyable. Mathematics teachers are advised to more frequently apply learning that utilizes contexts related to students' experiences, such as sports. The integration of swimming contexts into mathematics instruction expands the scope of study within the Realistic Mathematics Education approach, particularly in mathematics curricula that integrate physical education with mathematics an innovative approach rarely implemented at the junior high school level. The implications of this research for mathematics learning show that a mathematics approach using a swimming context is effective and makes learning in the mathematics curriculum more student-centered; students become more aware that mathematics is present in their daily lives, thereby reducing mathematical anxiety associated with the perceived intimidating nature of mathematics learning.

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