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Exploration of Learning Motivation and Concept Mastery on High School Students' Problem-Solving Abilities in the Reproductive System Material

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Abstract

Biology learning on the reproductive system topic requires students not only to understand concepts, but also to apply their knowledge to solve problems logically and contextually. This study aimed to describe students' learning motivation, concept mastery, and problem-solving ability, as well as to analyze the relationships among these variables. The research employed a quantitative approach with a descriptive-correlational design. The sample consisted of 26 students who had studied the reproductive system topic. The instruments used included a learning motivation questionnaire, a multiple-choice concept mastery test, and an open-ended problem-solving test. The data were analyzed descriptively and correlationally using SPSS Version 26. The results showed that the average score of students' learning motivation was 72.07, concept mastery was 69.23, and problem-solving ability was 74.70. The categorization results indicated that concept mastery and problem-solving ability tended to be in the good category, while learning motivation was still varied. The correlation test results revealed that learning motivation had a positive and significant relationship with concept mastery, with a correlation coefficient of 0.523 and a significance value of 0.006. Meanwhile, problem-solving ability did not show a significant relationship with either concept mastery or learning motivation. Based on these findings, it can be concluded that learning motivation plays an important role in supporting concept mastery, whereas problem-solving ability requires more directed practice, strategies, and experience in solving problems.

INTRODUCTION

Biology learning in high school aims not only to enable students to memorize scientific terms and facts, but also to enable them to understand concepts, analyze phenomena, and use their knowledge to solve problems in everyday life. Problem-solving skills are a crucial requirement in 21st-century learning, as students need to be trained to identify problems, formulate alternative solutions, implement problem-solving strategies, and evaluate the results of their problem-solving (Bell, 2010; Iwuanyanwu, 2020). However, the facts on the ground show that students' problem-

solving abilities in biology learning are still relatively low. Previous research found that high school students' problem-solving abilities in biology are still low, particularly in the indicators of planning solutions (23.40%), implementing plans (17.02%), and evaluating solutions (32.98%). These findings indicate that students are not yet fully capable of developing systematic solutions when faced with biological problems that require reasoning (Angraini et al., 2025).

Biology concepts are inherently complex and conceptually demanding, particularly topics related to the reproductive system, which is considered one of the most essential yet challenging subjects in secondary biology education. In addition to involving abstract biological processes, reproductive system material is closely related to adolescents' daily lives, thereby requiring students to develop deep conceptual understanding rather than relying solely on memorization. However, previous studies have shown that students' understanding of reproductive concepts remains relatively low and is often accompanied by misconceptions. A study conducted by Yahaya et al., (2020) revealed that although 69.9% of adolescents had understood the basic concepts of reproduction, approximately 30.1% of students still experienced difficulties in understanding several fundamental concepts. The study further identified misconceptions related to sexual behavior, pregnancy risks, and reproductive health consequences. Furthermore, a small proportion of adolescents still expressed agreement with premarital sexual behavior and sexual deviations. These findings indicate that reproductive system material remains highly vulnerable to misunderstanding when it is not taught through meaningful, accurate, and contextual learning processes (Yahaya et al., 2020; Urry et al., 2015).

Several previous studies have shown that students still experience difficulties in understanding concepts related to the human reproductive system. Research Salsabilla and Melta (2025) revealed that misconceptions were still found in several reproductive system sub-concepts, indicating that students' conceptual understanding remains inadequate. Likewise, a study conducted by Learning Difficulties of High School Students in Understanding Human Reproductive System Concepts found that the complexity of reproductive system material often hinders students from constructing accurate scientific concepts (Wahyuni et al., 2019). Furthermore, Utami et al (2020) reported that learning strategies emphasizing problem-solving significantly improved students' higher-order thinking skills on reproductive system material. These findings suggest that conceptual understanding and problem-solving skills remain important issues in reproductive system learning. Therefore, further investigation is needed to examine factors that may contribute to students' conceptual mastery and problem-solving abilities, including learning motivation.

The problem of low conceptual understanding is closely related to students' limited problem-solving skills, which are influenced not only by cognitive factors but also by the quality of the learning process implemented in the classroom (Al-Mutawah et al., 2019; Mangelep et al., 2023). Previous studies have reported that students' problem-solving skills in biology learning remain relatively low, particularly due to limited learning motivation, passive learning participation, and the continued use of conventional teaching approaches that do not sufficiently engage students in meaningful problem-solving activities (Fadwa et al., 2024; Fatmawati et al., 2024). Furthermore, learning environments that provide limited opportunities for active exploration and contextual learning may hinder students' ability to connect biological concepts with real-life situations. As a result, biology learning needs to be directed toward more student-centered and problem-based approaches that can foster conceptual understanding, critical thinking, and problem-solving skills simultaneously.

These conditions indicate that biology learning in schools still needs to be directed toward more active, contextual, and student-centered learning approaches that encourage students to actively construct knowledge and apply biological concepts in solving real-life problems. Therefore, meaningful learning experiences are necessary to improve students' conceptual

understanding and problem-solving skills, particularly in learning complex topics such as the reproductive system (Hmelo-Silver, 2004; Urry et al., 2015).

Students' difficulties in understanding the reproductive system are also related to adolescents' limited understanding of reproductive health. Previous research has shown that some adolescents still lack a thorough understanding of basic reproductive concepts. Limited knowledge regarding reproductive health, puberty, fertility, sexually transmitted infections, and reproductive functions remains a significant concern among adolescents, particularly due to inadequate access to accurate information and reproductive health education (Adjie et al., 2022; Saparini et al., 2023). Furthermore, discussions about reproductive health are often considered sensitive or taboo, so adolescents do not always receive accurate and comprehensive information from their families or schools. This situation emphasizes the importance of reproductive system education that focuses not only on mastering biological concepts but also equips students with the ability to understand reproductive information scientifically, critically, and responsibly (Amu & Adegun, 2015).

Conceptual mastery is a crucial aspect in learning about the reproductive system because students need a strong understanding of how to connect various interrelated biological processes. Biological concepts are generally complex, abstract, and interconnected, thus requiring a strong conceptual understanding so that students can build meaningful relationships between concepts (Cimer, 2012). Students with strong conceptual understanding are better able to explain scientific phenomena, establish relationships among biological concepts, and apply their knowledge to solve contextual problems (Saparini et al., 2023). Conversely, weak conceptual mastery can lead to students having difficulty understanding the interrelationships between biological concepts and analyzing issues related to reproductive health (Bahar et al., 1999).

In addition to conceptual mastery, learning motivation is also an important factor influencing students' success in understanding the material and solving problems. In the research conducted Ryan and Deci (2000) explains that intrinsic motivation is related to the drive from within to learn due to curiosity and interest in learning activities, while extrinsic motivation is related to the drive that comes from outside the student. Research conducted by Emda (2018) found that many students showed low enthusiasm and passive participation during science learning activities, particularly when learning was dominated by conventional teaching methods. Similarly, Sardiman (2016) emphasized that monotonous learning activities and limited student involvement may reduce students' intrinsic motivation to learn. Low learning motivation can negatively affect students' willingness to explore concepts deeply, resulting in weak conceptual understanding and limited problem-solving abilities. In biology learning, students who have high learning motivation tend to show better learning engagement, such as actively asking questions, diligently understanding complex concepts, and making more effort to complete tasks or problems that require reasoning and conceptual understanding (Pintrich et al., 1993) In biology learning, students who have high learning motivation tend to be more active in asking questions, more diligent in understanding difficult concepts, and more effort in solving problems or cases that require reasoning.

Learning motivation, conceptual mastery, and problem-solving skills are three interrelated aspects of reproductive system learning. Learning motivation plays a role in encouraging active student engagement during the learning process, while conceptual mastery serves as a foundation of knowledge that enables students to understand the relationships between concepts and apply them to problem-solving. Students with low learning motivation tend to be less motivated to study the material in depth, resulting in less than optimal engagement and understanding. On the other hand, weak conceptual mastery can cause students to experience difficulties in analyzing problems and developing appropriate solutions, despite their desire to learn. Therefore, studying the relationship between learning motivation, conceptual mastery, and problem-solving skills is

important to support reproductive system learning that is oriented not only toward theoretical conceptual mastery but also toward developing students' scientific, analytical, and problem-solving skills.

METHODS

This study employed a quantitative approach with a descriptive-correlational exploratory design. The quantitative approach was used because the data studied were scores or numbers obtained from questionnaires and tests. The exploratory design was used to gain an initial understanding of students' learning motivation, conceptual mastery, and problem-solving abilities in the reproductive system. Meanwhile, a descriptive-correlational design was used to describe the condition of each variable and to determine the relationship between learning motivation and conceptual mastery with students' problem-solving abilities. The subjects in this study were high school students who had studied the reproductive system. The sample consisted of 26 students who had complete data on learning motivation, concept mastery, and problem-solving skills. The sampling technique used was purposive sampling, which is a technique for determining samples based on specific criteria. The criteria used in this study were that students had learned the reproductive system material and participated in the entire data collection process.

The material studied in this study was the reproductive system in biology. This material covers the concepts of the structure and function of reproductive organs, gametogenesis, the menstrual cycle, fertilization, pregnancy, and reproductive system disorders. The research instruments consisted of a learning motivation questionnaire, a concept mastery test, and a problem-solving ability test. Learning motivation was measured using the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich (1999) on a scale of 1–8. This questionnaire covers three aspects: self-efficacy, intrinsic value, and anxiety, with a total of 22 items. The self-efficacy aspect consists of 9 items, intrinsic value 9 items, and anxiety 4 items.

Concept mastery is measured using a multiple-choice test that is structured based on indicators.Marzano and Kendall (2007) This instrument covers three levels of thinking: retrieval, comprehension, and analysis. Each level consists of five questions, resulting in a total of 15 questions on conceptual mastery. The retrieval level covers recognizing and recalling, the comprehension level covers integrating and symbolizing, and the analysis level covers matching and analyzing errors. Problem solving ability is measured using open-ended descriptive questions which are also developed based on indicators.Marzano and Kendall (2007) This instrument consists of four questions covering the ability to identify obstacles to goals, determine alternative solutions, evaluate each alternative, and select and implement the best solution. This test is used to assess students' ability to solve biological problems related to the human reproductive system logically and conceptually.

The independent variables in this study were learning motivation and concept mastery, while the dependent variable was problem-solving ability. Data were collected through questionnaires and tests administered to students after the learning process. All data collected was scored, tabulated, and then analyzed in accordance with the research objectives. Data analysis was conducted descriptively and correlationally. Descriptive analysis was used to determine the average, highest score, lowest score, and category of each variable. Correlational analysis used Pearson Product Moment to determine the direction, strength, and significance of the relationship between learning motivation, concept mastery, and problem-solving ability. The relationship between variables was declared significant if the significance value was less than 0.05.

RESULT AND DISCUSSION

This section presents the results of the research data analysis, which includes students' learning motivation, concept mastery, and problem-solving skills. These three aspects were analyzed to provide an overview of the students' condition after participating in the learning process, including their motivation to learn, understanding of the material, and their problem-solving abilities. The analysis results are presented in the form of descriptive statistical tables and categorization graphs to enable the data obtained to be explained more systematically and easily understood.

Table 1. Learning Motivation Results

Mean	Median	Max	Min
72.07	72.28	95.65	51.09

Based on the results of the descriptive analysis, students' learning motivation shows a diverse tendency, but in general it can still describe a fairly stable condition of learning motivation. This is in accordance with the view that learning motivation is a construct that is influenced by self-confidence, values towards tasks, learning strategies, and the emotional condition of students in participating in learning (Pintrich & Groot, 1990; Schunk, 2008).

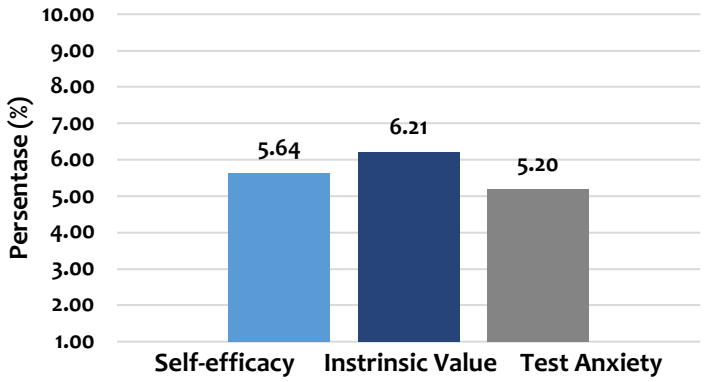


Figure 1. Average Results of Learning Motivation Indicators

In the motivation indicator graph, the intrinsic value aspect appears more prominent than other indicators, which shows that students have the motivation to learn because they consider learning valuable, interesting, and useful, while self-efficacy also plays an important role because belief in one's own abilities can increase effort, persistence, and involvement in learning (Bandura, 1997; Ryan & Deci, 2000; Zimmerman, 2000).

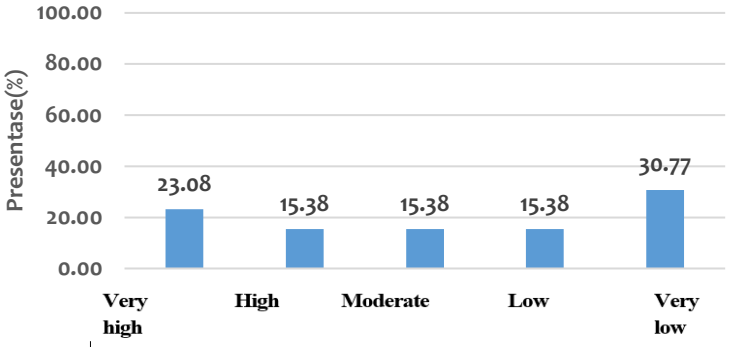


Figure 2. Learning Motivation Categorization Results

Meanwhile, the presence of students in the low to very low motivation category and the tendency of test anxiety indicators indicate that teachers still need to provide positive learning support, constructive feedback, and an evaluation atmosphere that is not too stressful, because academic anxiety can hinder learning performance, while support for student competence and autonomy can strengthen learning motivation (Cassady & Johnson, 2002; Pintrich, 1999). After analyzing learning motivation, the next discussion focused on students' conceptual mastery to assess their understanding of the material. Conceptual mastery is important to assess because a strong understanding provides the foundation for students to connect information, explain phenomena, and apply concepts in learning situations. The results of conceptual mastery are presented through descriptive analysis and categorization as follows.

Table 2. Concept Mastery Results

Mean	Median	Max	Min	Sdv
69.23	73.81	95.24	19.05	23.34

Based on the results of the descriptive analysis, students' mastery of concepts shows a fairly good tendency, because the average and median values show that most students have an adequate understanding of the concepts, although the difference between the highest and lowest values shows that students' abilities are not yet completely equal

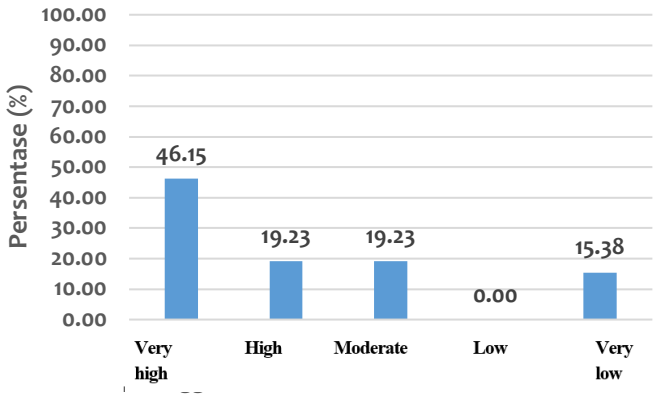


Figure 3. Concept Mastery Categorization Results

The concept mastery category graph shows that most students are in the very high category, while the low category does not appear prominent. This condition shows that the learning carried out has been able to help students understand the material, because concept mastery can increase when students are involved in active, exploratory, project-based, or technology-assisted learning that encourages them to build meaning from the concepts being studied (Setemen et al., 2023).

The continued presence of students in the moderate to very low categories indicates that teachers still need to provide reinforcement through formative assessment, feedback, conceptual exercises, and remedial learning, because recent research shows that formative assessment can help teachers identify misconceptions, adjust learning strategies, and improve students' conceptual understanding in a deeper and more sustainable manner (Lichtenberger et al., 2025).

In addition to learning motivation and conceptual mastery, problem-solving skills are also an important aspect that needs to be analyzed because they demonstrate students' ability to use their existing knowledge to solve problems. This ability relates to how students understand questions, analyze information, determine solution strategies, and evaluate the answers obtained. Therefore, students' problem-solving results are presented through descriptive analysis, indicator averages, and categorization as follows.

Table 3. Problem Solving Results

Mean	Median	Max	Min	Sdv
74.70	78.89	95.56	35.56	16.63

Based on the results of descriptive analysis, students' problem solving abilities show a good tendency, because the average and median values illustrate that most students have been able to understand and solve learning problems, although the range between the highest and lowest values shows that problem solving abilities between students still vary, this ability is important because problem solving in science learning requires students to understand concepts, analyze information, determine solution strategies, and evaluate the solutions obtained (Eticha et al., 2024; Pantiwati et al., 2022).

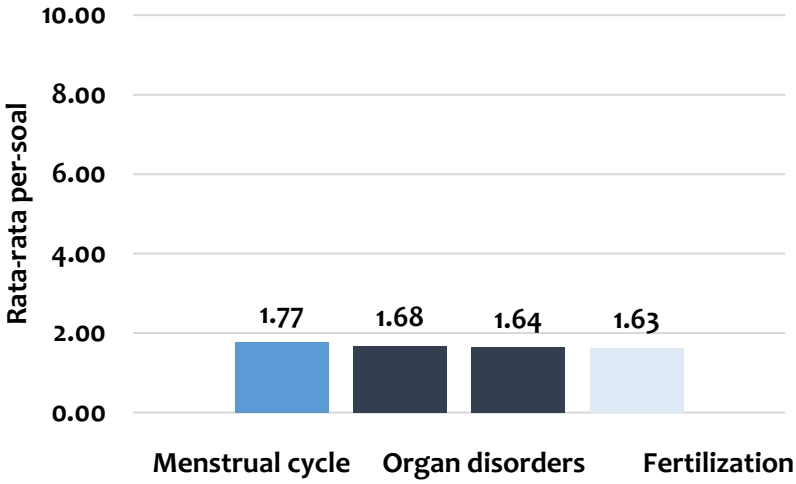


Figure 4. Average results per question category

In the average indicator graph, students' problem-solving abilities in the aspects of the menstrual cycle, organ disorders, and fertilization appear relatively close, so it can be interpreted that students have a fairly balanced ability to solve problems in the three materials, this condition is in line with research that shows that problem-based learning, the use of real contexts, concept maps, and metacognitive approaches can help students connect biological concepts with problem situations so that understanding and problem-solving abilities become better (Fadwa et al., 2024a).

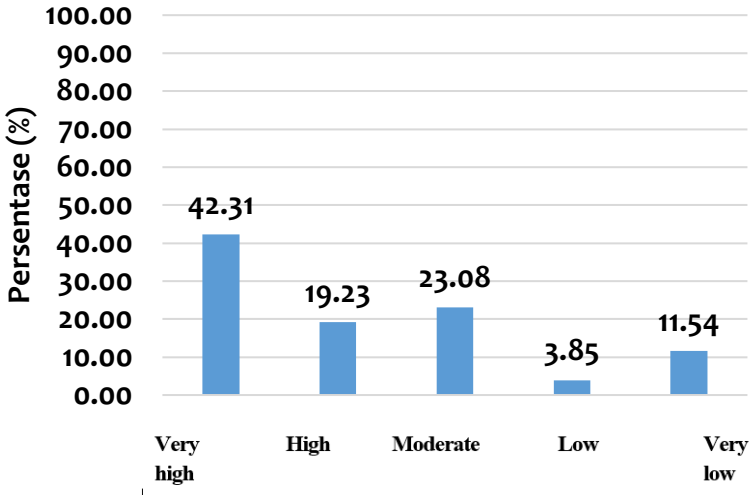


Figure 5. Problem Solving Categorization Results

Based on the categorization graph, most students are in the very high category, but there are still students in the medium to very low categories, so teachers need to strengthen problem-based learning, case discussions, contextual practice questions, formative assessments, and targeted feedback, because previous research shows that problem-solving development can be improved through active, collaborative, STEM-based learning, as well as formative assessments that help teachers identify students' difficulties and provide assistance according to their level of understanding (Ningrum et al., 2024; Pals et al., 2023).

Based on the categorization results, each variable shows a different distribution of student abilities. Therefore, the analysis continued with a correlation test to determine the relationship between learning motivation, problem solving, and concept mastery. The results of this correlation test were used to determine whether the differences in categories within each variable were significantly related to each other, as presented in Table 4.

Table 4. Correlation Results of Motivation, Problem Solving and Concept Mastery

Variable 1	Variable 2	Correlation Coefficient	Sig.(2-tailed)	N	Information
Problem Solving	Concept Mastery	0.301	0.135	26	Not significant
Problem Solving	Motivation	0.055	0.790	26	Not significant
Concept Mastery	Motivation	0.523**	0.006	26	Significant at the 0.01 level

Based on the results of the correlation test, the relationship between problem solving, concept mastery, and learning motivation showed different results for each pair of variables. The analysis results showed that the relationship between concept mastery and learning motivation had a correlation coefficient of $\rho = 0.523$ with a significance value of $p = 0.006$. This significance value is smaller than 0.01, so the relationship between concept mastery and learning motivation was declared significant at the 0.01 level. The positive direction of the relationship indicates that the higher the student's learning motivation, the higher their concept mastery tends to be. This finding is in line with Self-Determination Theory which states that motivation plays an important role in encouraging student involvement, persistence, and the quality of the learning process (Ryan and Deci, 2020).

The positive relationship between learning motivation and concept mastery can be explained by the fact that highly motivated students tend to be more active in learning, more diligent in completing assignments, and more invested in understanding the material. This aligns with Ryan and Deci's view that individuals will be more optimally engaged in learning activities when their psychological needs for autonomy, competence, and relatedness are met (Ryan & Deci, 2000). In addition, Bandura's self-efficacy theory also explains that belief in one's own abilities can influence a person's choice of actions, effort, persistence, and learning achievement (Schunk & DiBenedetto, 2021). Students who have better learning motivation tend to have a stronger drive to understand concepts in depth.

The positive and significant correlation between learning motivation and conceptual mastery suggests that students with stronger motivation tend to engage more actively in learning activities, which subsequently supports deeper conceptual understanding. As explained Ryan & Deci, (2000) that motivation can increase engagement and persistence in learning. as well as Bandura, (1997) that motivation and self-confidence influence students' efforts in achieving learning outcomes. In biology learning, students who have high learning motivation tend to show better learning engagement, such as actively asking questions, diligently understanding complex concepts, and making more effort to complete tasks or problems that require reasoning and conceptual understanding (Pintrich et al., 1993).

Based on the correlation analysis, the insignificant relationship between problem-solving skills and concept mastery may be explained by the fact that these variables represent different dimensions of learning. Concept mastery primarily reflects students' understanding of subject matter, whereas problem-solving skills require more complex cognitive processes, including identifying problems, selecting appropriate strategies, applying knowledge, evaluating alternative solutions, and reflecting on the outcomes. In this study, problem-solving skills were assessed through open-ended essay questions based on the indicators proposed by Marzano and kendall (2007), namely identifying obstacles to goals, generating alternative solutions, evaluating alternatives, and selecting and implementing the most appropriate solution. Therefore, students with high conceptual mastery do not necessarily demonstrate strong problem-solving skills, as effective problem solving requires not only conceptual knowledge but also metacognitive regulation, strategic thinking, and the ability to apply knowledge in unfamiliar situations. This finding is consistent with recent studies suggesting that successful problem solving involves the integration of conceptual understanding, metacognitive processes, and higher-order thinking skills (Mangelep et al., 2023; Ndiung & Menggo, 2024). Furthermore, effective problem solving requires students to identify relevant information, select appropriate strategies, apply conceptual knowledge, and evaluate the effectiveness of their solutions (Gebremeskel et al., 2025). These findings indicate that while conceptual mastery provides an important foundation for problem solving, it alone may not be sufficient to ensure students' success in solving complex problems.

The categorization results also support these findings, as conceptual mastery had the largest number of students in the very high category at 46.15%, while problem solving was in the very high category at 42.31%, but there were still 23.08% of students in the medium category, 3.85% in the low category, and 11.54% in the very low category. These findings suggest that high conceptual mastery does not necessarily translate into high problem-solving performance for all students. Thus, conceptual mastery is an important foundation, but not enough to guarantee problem-solving ability, because problem solving requires practice, strategy, experience, and the ability to use knowledge in new situations. This is reinforced by previous research which explains that meaningful learning requires not only mastery of information, but also the ability to use knowledge in new contexts (Medicine et al., 2000).

The results of the correlation test between problem solving and learning motivation show a significance value greater than 0.05, so the relationship between problem solving and learning motivation is declared insignificant. A very small correlation coefficient value indicates that the relationship between the two variables is very weak. In theory, learning motivation can encourage students to be more active, diligent, and involved in the learning process, because motivation plays a role in directing learning behavior and maintaining students' efforts in achieving learning goals (Ryan & Deci, 2000) However, the results of this study indicate that learning motivation is not significantly related to problem-solving ability. This may occur because problem-solving ability is not only determined by the motivation to learn, but is also influenced by the ability to understand problems, choose strategies, apply knowledge, evaluate alternatives, and reflect on the problem-solving process (Hmelo-Silver, 2004). Thus, students who have high learning motivation do not necessarily have high problem-solving skills if they are not used to solving problem-based questions or do not yet have the right problem-solving strategies.

When associated with the categorization results, the problem solving variable shows that 42.31% of students are in the very high category, while the learning motivation variable is the largest category in the very low category, namely 30.77%. Individually by category, the number of students in the very high problem solving category reaches approximately 11 people, while the number of students in the very high motivation category is only approximately 6 people. Conversely, the number of students with very low motivation reaches approximately 8 people, but the number of students with very low problem solving is only approximately 3 people. This difference in category patterns indicates that the distribution of problem solving and learning motivation does not move in the same direction, thus supporting the results of a very weak and insignificant correlation. This

condition indicates that problem solving ability is a multidimensional skill influenced by various factors besides motivation, such as mastery of concepts, the use of metacognitive strategies, learning experience, and the ability to apply knowledge in different contexts (Hmelo-Silver, 2004; Jonassen, 2010).

The findings of this study indicate that students' learning motivation varied considerably among students, with a substantial proportion still demonstrating low to very low levels of motivation. Similarly, students' problem-solving skills showed a relatively positive tendency, although the distribution of achievement was not evenly distributed, as some students remained in the moderate, low, and very low categories. Furthermore, the correlation analysis revealed that learning motivation was not significantly associated with problem-solving skills, whereas a significant positive relationship was found between learning motivation and conceptual mastery. These findings suggest that improving students' motivation alone may not be sufficient to enhance their problem-solving abilities. Therefore, an instructional approach that simultaneously promotes active engagement and develops higher-order thinking skills is needed.

One instructional approach that has the potential to address these challenges is the Collaborative Constructive approach. This approach emphasizes students' active participation in constructing knowledge through collaboration, discussion, and shared problem-solving experiences. In the context of reproductive system learning, students can be engaged in analyzing authentic and contextual problems related to reproductive health, reproductive disorders, and other biological phenomena relevant to their daily lives. Through collaborative interactions, students are encouraged to exchange ideas, evaluate different perspectives, and develop solutions collectively. Such learning experiences not only facilitate deeper conceptual understanding but also foster critical thinking, reasoning, and problem-solving skills.

Therefore, the Collaborative Constructive approach is considered highly relevant for teaching the reproductive system because it integrates the development of learning motivation with the enhancement of problem-solving skills. A collaborative learning environment can increase students' participation, engagement, and responsibility in the learning process, while constructive activities enable them to actively build meaningful connections between biological concepts and real-world situations. Based on these considerations, further research is needed to investigate the effectiveness of the Collaborative Constructive approach in improving senior high school students' learning motivation and problem-solving skills in reproductive system learning.

CONCLUSION

Based on the results of this study, students' learning motivation, concept mastery, and problem-solving skills in reproductive system material showed varying conditions. Concept mastery and problem-solving skills tended to be in the good category, while learning motivation demonstrated a more diverse distribution among students. The correlation analysis revealed that learning motivation had a positive and significant relationship with concept mastery, indicating that students with higher learning motivation tended to achieve better understanding of biological concepts. In contrast, problem-solving ability did not show a significant relationship with either concept mastery or learning motivation. These findings suggest that problem-solving skills are not solely influenced by students' motivation or conceptual understanding, but also require additional abilities such as identifying problems, determining alternative solutions, evaluating possible solutions, and selecting and implementing the most appropriate strategies. The findings of this study provide important implications for biology learning, particularly in reproductive system material. Teachers are encouraged to implement more student-centered and problem-based learning approaches that can facilitate students in connecting conceptual understanding with real-life biological problems. Learning activities such as case discussions, contextual exercises, collaborative learning, and formative assessments may help students improve both conceptual

mastery and problem-solving skills more effectively. In addition, creating a supportive and engaging learning environment may help strengthen students' learning motivation and participation during the learning process. However, this study was limited by the relatively small sample size and its focus on a single biology topic. Therefore, further research is recommended to involve larger and more diverse samples, explore different biology materials, and examine additional variables such as critical thinking skills, metacognitive abilities, learning strategies, and classroom environment to gain a broader understanding of the factors influencing students' problem-solving skills. Future studies are also encouraged to investigate the effectiveness of specific learning models in improving students' motivation, conceptual understanding, and problem-solving abilities simultaneously. In particular, collaborative and constructive learning approaches may offer promising opportunities to support the development of these interconnected learning outcomes in reproductive system learning.

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