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The relationship between intrapersonal intelligence and biology learning outcomes in schools: A literature review

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Abstract. Despite numerous studies showing correlations between various factors and biology learning outcomes, comprehensive synthesis on the specific role of intrapersonal intelligence in biology education remains limited, particularly regarding the psychological mechanisms underlying this relationship. This study aimed to systematically review and synthesize existing research on the relationship between intrapersonal intelligence and students' biology learning outcomes in schools. This systematic review analyzed ten national and international research articles published between 2020 and 2025, obtained from the Google Scholar database. The findings reveal a consistent positive correlation between intrapersonal intelligence and students' biology learning outcomes across various educational levels, with correlation coefficients ranging from r = 0.35 to r = 0.47. Furthermore, the review highlights several psychological and pedagogical mechanisms, including internal motivation, metacognitive regulation, reflective problem solving, and adaptive learning, through which intrapersonal intelligence enhances learning outcomes. These results emphasize the importance of integrating intrapersonal intelligence development into biology instruction to foster students' autonomy, motivation, and conceptual understanding. The practical implication suggests the need for educators to design reflective and self regulated learning strategies to optimize biology learning performance.

Abstrak. Studi yang ada telah menunjukkan korelasi antara berbagai faktor dengan hasil belajar biologi, namun sintesis komprehensif mengenai peran spesifik kecerdasan intrapersonal dalam pendidikan biologi masih terbatas, terutama terkait mekanisme psikologis yang mendasarinya. Penelitian ini bertujuan untuk meninjau dan mensintesis secara sistematis penelitian yang ada mengenai hubungan antara kecerdasan intrapersonal dan hasil belajar biologi siswa di sekolah. Tinjauan sistematis ini menganalisis sepuluh artikel penelitian nasional dan internasional yang diterbitkan antara tahun 2020 hingga 2025, yang diperoleh dari basis data Google Scholar. Hasil tinjauan mengungkapkan adanya korelasi positif yang konsisten antara kecerdasan intrapersonal dan hasil belajar biologi di berbagai jenjang pendidikan, dengan koefisien korelasi berkisar antara r = 0,35 hingga r = 0,47. Selain itu, tinjauan ini menyoroti beberapa mekanisme psikologis dan pedagogis, termasuk motivasi internal, regulasi metakognitif, pemecahan masalah reflektif, dan pembelajaran adaptif, sebagai jalur peningkatan hasil belajar. Temuan ini menekankan pentingnya mengintegrasikan pengembangan kecerdasan intrapersonal ke dalam pengajaran biologi untuk meningkatkan otonomi, motivasi, dan pemahaman konseptual siswa. Implikasi praktisnya adalah perlunya pendidik merancang strategi pembelajaran reflektif dan teregulasi diri guna mengoptimalkan kinerja belajar biologi.

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Introduction

Biology education plays a strategic role in developing students' scientific literacy, which encompasses the ability to use scientific knowledge, identify questions, and draw conclusions based on scientific evidence (OECD, 2019). As a branch of science that studies living organisms and life, biology requires students not only to memorize concepts but also to understand complex processes, conduct scientific investigations, and apply knowledge in real-world contexts (Rustaman, 2016; Campbell & Reece, 2008). Critical thinking skills, problem solving abilities, and science process skills developed through biology learning serve as important provisions for students to face 21st century challenges (Fuad et al., 2020). However, Indonesian students'biology learning outcomes still show considerable variation and are not yet optimal, as reflected in the achievement of scientific literacy in the Programme for International Student Assessment (PISA), which, although improved from 2018 to 2022, has not yet positioned Indonesia competitively at the global level (OECD, 2023).

Biology learning outcomes are influenced by various factors, both internal and external. Internal factors include physiological and psychological aspects such as intelligence, interest, motivation, and cognitive abilities, while external factors encompass family, school, and community environments (Slameto, 2015; Syah, 2017). In the context of biology learning, research shows that internal factors such as critical thinking skills, metacognitive skills, and multiple intelligences have significant contributions to students' learning success (Puspitasari et al., 2021). Among these various internal factors, intrapersonal intelligence receives special attention in contemporary educational studies due to its role in supporting independent and directed learning.

Intrapersonal intelligence, as explained in Gardner's (1983) Multiple Intelligences theory, is the ability to understand oneself, recognize emotions, motivations, strengths, and weaknesses. This intelligence includes the capacity for introspection, self reflection, metacognitive awareness, and the ability to use self understanding in planning and directing the learning process (Armstrong, 2009; Yaumi, 2012). Students with high interpersonal intelligence possess characteristics such as the ability to recognize and regulate emotions, good metacognitive awareness, the ability to set realistic learning goals, objective self evaluation, and strong intrinsic motivation. These abilities enable students to engage in self regulated learning, which means organizing and controlling their own learning process to achieve optimal results (Zimmerman, 2002).

The relevance of intrapersonal intelligence in biology learning can be seen from several aspects. First, biology learning requires deep conceptual understanding and the ability to connect new knowledge with personal experiences (Ganesan et al., 2021). Students with high intrapersonal intelligence are able to reflect on their learning process, identify effective strategies, and adjust their learning approaches according to their needs. Second, biology practicum requires the ability to evaluate self understanding, identify difficulties, and seek solutions independently. Third, contextual biology learning requires students to connect material with daily life and their personal values, which is an important aspect of intrapersonal intelligence (Sulistiyowati & Andriani, 2017).

Several studies have explored the relationship between intrapersonal intelligence and biology learning outcomes, showing consistent positive correlations. Kurniawan (2019) found a significant positive relationship with a contribution of 35.6% to the variance in learning outcomes. Wajdi et al. (2018) reported a significant correlation ($r = 0.412$, $p < 0.05$) among grade XI science students in Makassar. Ningsih (2022) also found a significant relationship with cognitive biology learning outcomes. International research supports these findings, such as the study by Ganesan et al. (2021) showing the significant impact of intrapersonal emotional intelligence on science academic achievement, and Tarrayo et al. (2023) reporting a positive relationship with science academic achievement. The meta analysis by Fernández-Martín et al. (2022) also confirmed significant correlations between various types of intelligence, including intrapersonal, and academic performance.

Despite numerous studies examining this relationship, several important gaps need attention. First, most research is correlational in nature and has not explored the mechanisms or psychological processes underlying the relationship between intrapersonal intelligence and biology learning outcomes. Second, previous research was generally conducted on limited samples and specific contexts, so the generalization of results still needs further examination. Third, comprehensive reviews that synthesize various research findings on the relationship between intrapersonal intelligence and biology learning outcomes, particularly in the Indonesian education context, remain very limited. Fourth, there have not been many studies analyzing the practical implications of these research findings for biology learning design in schools.

Based on these gaps, this review aims to identify and examine previous research findings that discuss the relationship between intrapersonal intelligence and students' learning outcomes in the context of biology education. Specifically, this study answers the questions:

1. What is the relationship between intrapersonal intelligence and biology learning outcomes in schools?
2. What are the components of intrapersonal intelligence that most influence biology learning outcomes?
3. How do the mechanisms of intrapersonal intelligence affect the biology learning process and outcomes?

This review is expected to provide theoretical and practical foundations for developing more effective biology learning strategies by considering the role of students' intrapersonal intelligence.

Research Methods

1) Research Type

This study employs the Systematic Literature Review (SLR) method to identify, evaluate, and synthesize research findings relevant to the relationship between intrapersonal intelligence and biology learning outcomes.According to Afsari et al. (2021), systematic literature review is a method used to analyze, examine, and explain existing research to answer formulated research problems. This method was chosen for its ability to provide comprehensive and objective synthesis of various empirical studies.

2) Data Sources and Search Strategy

Data sources for this literature review were obtained from the Google Scholar digital database. The data search process was conducted on September 24, 2025, using a combination of keywords: "Intrapersonal Intelligence" AND "Biology Learning Outcomes" OR "Academic Achievement" OR "Student Performance". The search was conducted on articles published within the 2020-2024 timeframe to ensure relevance and recency of findings. The five-year time limitation was chosen considering recent developments in educational psychology and biology learning.

3) Selection Criteria

Article selection was conducted with reference to inclusion and exclusion criteria presented in Table 1. These criteria were compiled based on the framework by Fajeriadi et al. (2024) to ensure the quality and relevance of reviewed articles.

Table 1 Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Studies relevant to the topic	Non empirical studies
Published within the last 5 years	Publications in languages other than English/Indonesian
Studies with empirical methods	Conference papers, dissertations, or research reports
Full access to articles	Studies with small samples
Publications in national journals	Articles not providing required data

4) Article Selection Procedure

The article selection process follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, consisting of four main stages, as shown in Figure 1:

(1) Identification

Initial search in Google Scholar using predetermined keywords yielded 4,165 articles. All these articles were identified and documented in an initial database.

(2) Screening

At this stage, screening was conducted based on titles and abstracts. Articles clearly relevant to the topic, duplicates, or not meeting publication year criteria were eliminated. The screening process resulted in 127 potentially relevant articles.

(3) Eligibility

The 127 articles that passed screening were then evaluated for eligibility through full text reading. At this stage, articles were assessed based on established inclusion and exclusion criteria, particularly regarding methodological quality, data completeness, and publication type. Articles not meeting these criteria were excluded with recorded exclusion reasons.

(4) Included

After passing through the three previous stages, 10 articles were obtained that met all criteria and were suitable for further analysis in this review. These ten articles represent high quality studies that specifically examine the relationship between intrapersonal intelligence and biology learning outcomes.

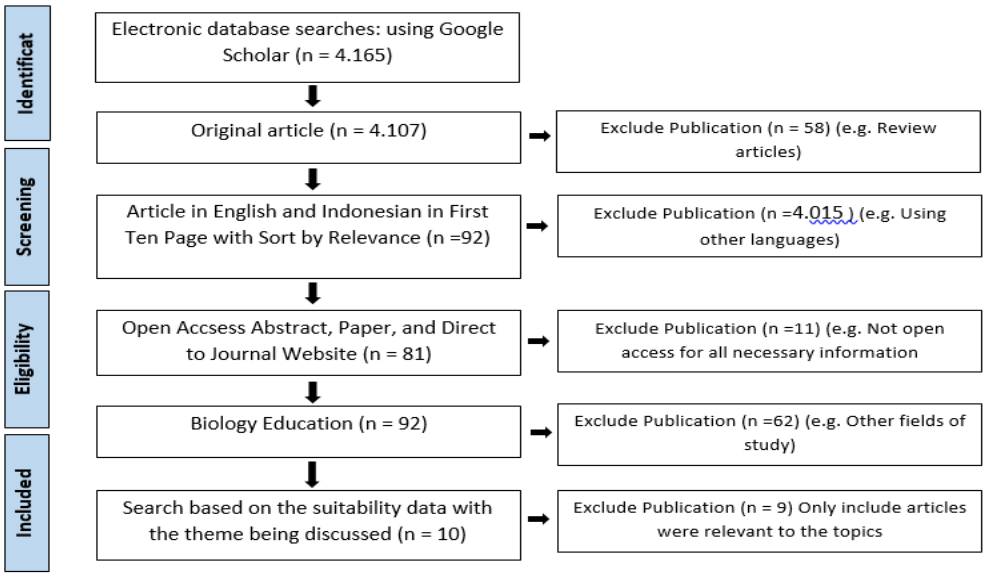

Figure 1 Systematic literature review flowchart

5) Data Collection Technique

The data collection technique was conducted by extracting key information from each selected article, including: (1) article identity (author, year, title), (2) sample characteristics (number, education level, location), (3) research methods used, (4) instruments for measuring intrapersonal intelligence and biology learning outcomes, (5) main findings related to the relationship between the two variables, and (6) research conclusions. Extracted data were then compiled in a synthetic matrix to facilitate cross study comparative analysis.

The data analysis technique used is descriptive analysis with a content analysis approach. According to Saefullah (2024), content analysis is a method used to discover patterns, themes, and meanings contained in literature used as data sources. In this study, analysis was conducted through stages: (1) reading and deeply understanding all selected articles, (2) identifying and categorizing main findings based on research questions, (3) comparing results across studies to find patterns of consistency or inconsistency, (4) synthesizing findings to answer research questions, and (5) identifying theoretical and practical implications from synthesis results. This analysis process allows researchers to reveal comprehensive understanding of the relationship between intrapersonal intelligence and biology learning outcomes based on available empirical evidence.

Results and Discussion

The distribution of analyzed articles shows increasing research interest in intrapersonal intelligence in biology learning, with 3 articles (30%) published in the 2020-2021 period, 4 articles (40%) in 2022-2023, and 3 articles (30%) in 2024-2025. This trend indicates the continuing relevance of the intrapersonal intelligence topic in contemporary biology education contexts.

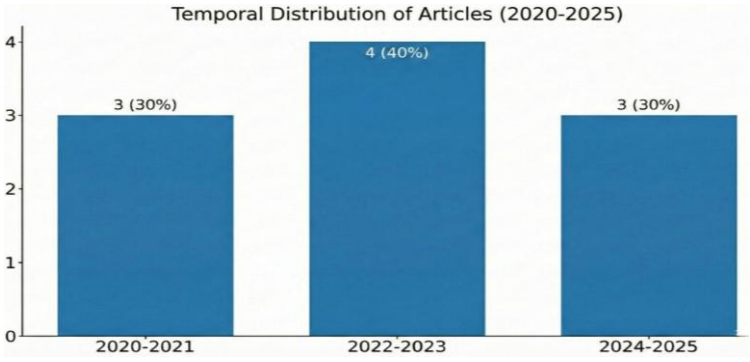

Figure 2 Bar graph of research article publications on the relationship between intrapersonal intelligence and biology learning outcomes for the period 2021-2025 (n=10)

From a methodological aspect, the majority of articles (60%, n=6) used a quantitative correlational approach, followed by descriptive qualitative approaches (20%, n=2), systematic review (10%, n=1), and action research (10%, n=1). The dominance of quantitative correlational methods indicates that current research focus remains on identifying statistical relationships between variables, although this method has limitations in explaining the causal mechanisms underlying these relationships. This represents one of the methodological gaps that needs to be addressed through experimental and longitudinal research in the future.

The article selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyses) protocol. From 4,165 articles identified through Google Scholar, title and abstract based screening was conducted, leaving 50 potential articles. After full text assessment applying strict inclusion and exclusion criteria, 10 final articles met quality standards for in depth analysis. The high exclusion rate (99.76%) indicates the specificity of the research topic and the strictness of criteria applied to ensure relevance and quality of reviewed articles.

Article selection from systematic review results using the PRISMA model within the Systematic Literature Review (SLR) framework yielded 10 articles published in reputable peer reviewed national and international journals, detailed further in Table 2.

Table 2 Synthesis of research articles on the relationship between intrapersonal intelligence and biology learning outcomes (2020-2025)

Code	Researcher	Problem	Method	Findings
A1	Rahmawati et al. (2023)	Relationship between intrapersonal intelligence and motivation on Biology learning outcomes	Quantitative/correlational; questionnaire & learning outcomes test (n≈100)	Positive correlation between intrapersonal and learning outcomes (r=0.351); intrapersonal + motivation → r=0.472
A2	Hani et al. (2024)	Multiple intelligences characteristics and potential utilization for Biology learning (senior high school)	Qualitative descriptive: MIquestionnaire + teacher interviews	Many students show intrapersona dominance; intrapersonal has potential to enhance performance on independent tasks/portfolios
A3	Zahra et al. (2021)	Effect of intrapersonal intelligence on problem solving ability in Biology	Quantitative correlational; intrapersonal questionnaire and problem solving test (n≈35)	Intrapersonal has significant positive effect on Biology problem solving ability (r≈0.41; contribution ≈17.4%)
A4	Nurhasanah & Safitri (2022)	Effect of intrapersonal intelligence on science learning outcomes on Biology material (elementary school)	Quantitative experiment (experimental vs control class), questionnaire & test	Positive effect of intrapersonal conscience/Biology outcomes found
A5	Andima et al. (2021)	Relationship between multiple intelligences (including intrapersonal) and Biology learning outcomes	Descriptive correlation (Spearman) on senior high school students	Most intelligence types significantly related to Biology outcomes; intrapersonal analyzed as one variable
A6	Manik & Nurhayati (2023)	Analysis of multiple intelligences (including intrapersonal) in grade XII Biology learning activities	Descriptive analytical; MI questionnaire + documentation (n=40)	Intrapersonal measured (moderate/high percentage) and linked to learning outcome indicators/ engagement; shows potential intrapersonal effect on Biology outcomes
A7	Khatoon & Ambreen (2023)	Multiple intelligences profile of Biology students & relationship with Biology learning outcomes	Quantitative survey on Biology students;correlation analysis	MI profile shows intrapersonal as one dimension; study reports positive relationship between several MI (including intrapersonal) and Biology outcomes
A8	Nasution (2025)	MI of prospective Biology teachers:intrapersonal & implications for Biology learning achievement	Survey & descriptive analysis + correlation (Biology Education students)	Students with high intrapersonal tend to be more reflective and prepare Biology teaching more maturely → potentially improves learning outcomes when teaching
A9	Ikrima (2021)	Improvement of intrapersonal through action research cycles in Biology learning & effecton learning outcomes	Classroom action research;intrapersonal measurement + Biology learning outcomes	Increased intrapersonal percentage followed by increased Biology learning outcomes in subsequent cycles
A10	Afnan et al. (2025)	Role of Multiple Intelligences theory (including intrapersonal) in cognitive transformation and Biology learning outcomes	Systematic literature review related to MI & Biology learning (2015-2024 studies)	Cumulative evidence: MI integration (including intrapersonal strengthening) supports Biology concept understanding & knowledge transfer; intrapersonal emerges as important factor in numerous studies

This literature review analyzes ten research articles relevant to the relationship between interpersonal intelligence and biology learning outcomes to answer the three formulated research questions. As explained in the introduction, intrapersonal intelligence is one of the internal factors influencing learning outcomes, but comprehensive reviews synthesizing various research findings on this relationship, particularly in the Indonesian education context, remain very limited. Therefore, the following data analysis is structured to fill this gap by identifying consistent patterns from various previous studies through a thematic synthesis approach.

Analysis of the reviewed articles consistently shows that there is a positive and significant correlation between students' intrapersonal intelligence and biology learning outcomes in schools. This relationship pattern varies from moderate to strong, indicated by correlation coefficients ranging from r= 0.351 to r= 0.472. Specifically, Rahmawati et al. (2023) found a direct positive correlation (r= 0.351) that increased in strength (r= 0.472) when intrapersonal intelligence synergized with learning motivation. This finding underscores the important contribution of intrapersonal intelligence, which includes the ability to regulate behavior and possess intrinsic motivation, to achieving biology learning outcomes. Besides general learning outcomes, interpersonal intelligence also significantly supports students' higher order cognitive abilities, evidenced by Zahra et al. (2021) who reported a significant positive effect on biology problem solving ability (r≈0.41) with a contribution of 17.4%. Thus, intrapersonal intelligence plays a strategic role in meeting biology learning demands, which test not only concepts but also problem solving abilities.

Collectively, findings from various studies strengthen evidence that the positive relationship between intrapersonal intelligence and biology learning outcomes is consistent across educational levels and geographical contexts. This consistency is important as it addresses the need for generalization of previous research results that were generally limited to specific samples or contexts. For example, Nurhasanah & Safitri (2022) through quantitative experimental design found a positive effect of intrapersonal intelligence on elementary school students' science/biology learning outcomes, consistent with findings at higher levels. Support also comes from global contexts, where Khatoon et al. (2023) reported a positive relationship between multiple intelligences, including intrapersonal, and biology learning outcomes in Pakistan. Furthermore, a correlational study on high school students by Andima et al. (2021) showed that intrapersonal intelligence is one variable significantly related to biology learning outcomes, reinforced by findings from Manik & Nurhayati (2023) that intrapersonal intelligence is measurable and has potential effect on biology learning outcome indicators. These consistent findings collectively confirm the argument that intrapersonal intelligence has a strategic role in biology learning, especially in meeting demands requiring understanding of complex life processes and knowledge application in real contexts.

The review of various examined studies underscores self reflection ability as a crucial element of interpersonal intelligence most significantly affecting biology learning outcomes. Evidence from Hani (2024) shows that students with dominant intrapersonal intelligence achieve optimal performance in independent tasks and biology portfolios. This finding implies that self reflection is key for students to objectively evaluate their understanding, consistent with characteristics of students with high intrapersonal intelligence. This finding is reinforced by Nasution (2025), who noted that prospective biology teacher students with high interpersonal intelligence tend to be more reflective and prepare biology teaching more maturely, potentially improving learning achievement. Furthermore, Afnan et al. (2025) found that strengthening intrapersonal intelligence cumulatively supports concept understanding and biology knowledge transfer.

Besides self reflection, learning independence is an important component of intrapersonal intelligence that impacts biology learning outcomes. Rahmawati et al. (2023) recommended strengthening interpersonal intelligence through independent tasks and reflective activities to improve learning outcomes, consistent with Hani's (2024) recommendations regarding portfolio use and self assessment to optimize biology achievement. This consistency of recommendations confirms that learning independence is crucial and aligns with the concept of self regulated learning. Practical recommendations such as multiple intelligences assessment suggestions by Manik & Nurhayati (2023) and implementation of reflective/independent learning on biology material by Nurhasanah & Safitri (2022) provide real implications that address the need for practical implication studies in biology learning design.

Self awareness is another component of intrapersonal intelligence showing a vital role in the biology learning process. Nasution (2025) explicitly elaborates on the contribution of intrapersonal intelligence to self awareness and prospective biology teachers' learning strategies, where individuals with high intrapersonal intelligence show better awareness of their learning strengths and weaknesses, consistent with Armstrong's (2009) main definition of intrapersonal intelligence. Furthermore, Andima et al. (2021) suggested adapting teaching strategies based on multiple intelligences mapping, confirming the importance of students' self awareness of their learning potential. Meanwhile, independent problem solving ability was also identified as crucial; Zahra et al. (2021) found significant effect of intrapersonal intelligence on this ability and recommended problem based tasks to train reflection/independence. This component shows that students with high intrapersonal intelligence are better able to analyze and solve biology problems effectively, consistent with contemporary critical thinking demands.

Analysis of reviewed articles reveals several interrelated mechanism pathways explaining how intrapersonal intelligence affects biology learning processes and outcomes. The internal motivation mechanism becomes one of the main pathways, as shown by Rahmawati et al. (2023) who found that the combination of interpersonal intelligence with learning motivation produces stronger correlation (r=0.472) compared to interpersonal intelligence alone (r=0.351). This shows that intrapersonal intelligence works through internal motivation mechanisms, where students with good self-understanding tend to have higher intrinsic motivation to learn biology. This finding addresses the gap identified in the introduction that most existing research is correlational and has not explored the mechanisms or psychological processes underlying the relationship between intrapersonal intelligence and learning outcomes.

The metacognitive mechanism also plays a key role in explaining the impact of intrapersonal intelligence on biological learning outcomes. Nasution (2025) describes that students with high intrapersonal levels show more reflective characteristics and more detailed learning preparation, indicating metacognitive mechanisms. This means students are able to plan, monitor, and evaluate their own learning process regarding complex biology concepts, consistent with metacognitive awareness characteristics. Additionally, Afnan et al. (2025) found that systematic intrapersonal strengthening supports knowledge transfer and biology concept understanding, which are indicators of metacognitive process effectiveness.

Another pathway explaining the effect of intrapersonal intelligence on biology learning outcomes is through independent and adaptive learning mechanisms. Hani (2024) shows that students with dominant interpersonal intelligence achieve optimal performance on portfolio and independent tasks, confirming the self regulated learning mechanism. Additionally, recommendations from Andima et al. (2021) and Khatoon et al. (2023) regarding the need for intelligence profile mapping and teaching strategy adaptation indicate that interpersonal intelligence enables students to effectively adapt to various biology learning strategies according to their needs.

Another significant role is represented by the reflective problem solving mechanism. Zahra et al. (2021) show that intrapersonal intelligence directly affects biology problem solving ability through reflection processes. In this process, students with high intrapersonal intelligence are able to analyze biology problems by considering their personal experiences and knowledge, while evaluating the effectiveness of problem solving strategies used. This finding is highly relevant to biology practicum demands that often require self evaluation and independent solution seeking.

Empirical evidence regarding how intrapersonal intelligence can be developed to improve biology learning outcomes is provided by the pedagogical intervention mechanism. Ikrima (2021) found through classroom action research that increased intrapersonal intelligence percentage is directly proportional to improved biology learning outcomes in subsequent cycles. This proves that planned pedagogical interventions, such as reflective activities, can directly improve learning achievement. Furthermore, Nurhasanah & Safitri (2022) through experimental design proved the positive effect of implementing reflective/independent learning on biology material, confirming that appropriate pedagogical intervention mechanisms can optimize the role of intrapersonal intelligence in the learning process.

The final pathway explaining the comprehensive influence of intrapersonal intelligence on biology learning is the cognitive transformation mechanism. Afnan et al. (2025) found evidence that integration of multiple intelligences, including intrapersonal strengthening, facilitates cognitive transformation in biology learning.This mechanism functions to facilitate the process of internalizing and reorganizing biology knowledge, which in turn produces deeper concept understanding and better knowledge transfer ability. This is highly consistent with modern biology learning objectives, namely forming students' scientific literacy to understand contemporary issues based on scientific evidence.

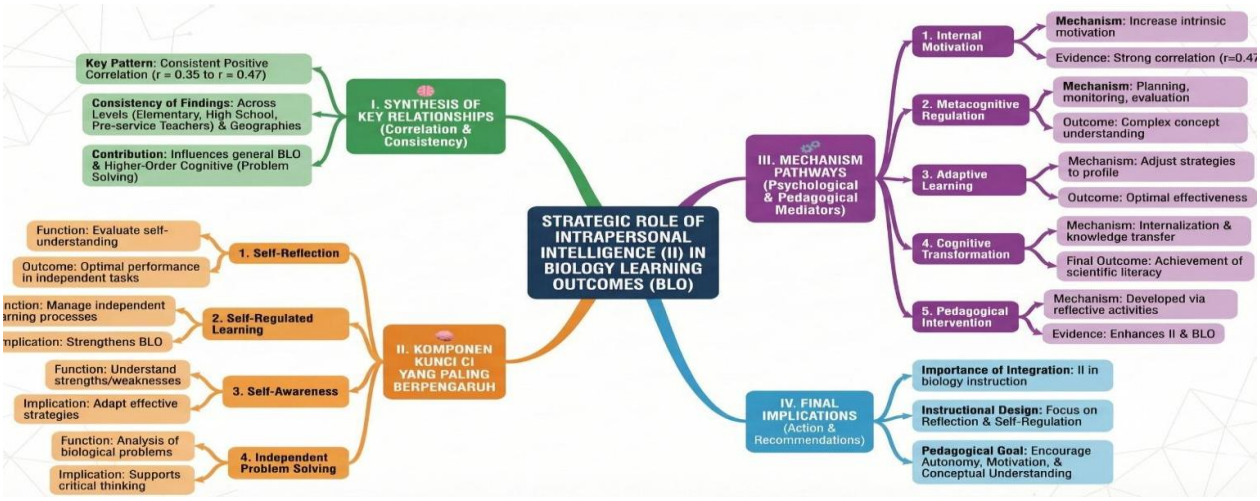

Figure 3 Mind map of intrapersonal intelligence strategy roles in biology learning outcomes

Conclusion

The review results show that intrapersonal intelligence consistently has a positive effect on biology learning outcomes through metacognition and learning independence mechanisms sourced from self reflection ability. This finding fills the literature gap regarding the importance of integrating intrapersonal strategies in instructional design to optimize student potential adaptively. Given the limitations in methodological variation of analyzed studies, future research is recommended to explore experimental designs and develop intrapersonal-based learning interventions to produce stronger and more applicable pedagogical recommendations.

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