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Needs Analysis of Metacognitive Strategy Integration in Electronic Module Development to Improve Higher Order Thinking Skills

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ABSTRACT

This study aims to identify and explore metacognitive strategies that can be integrated into electronic modules to improve Higher Order Thinking Skills (HOTS). The initial research was conducted on 49 respondents from students majoring in Biology Education. The data collection instrument used a metacognitive test with 5 indicators: 1) Design what 2) elaboration; 3) Identify 4) Implement 5) Troubleshooting. The results of the metacognitive ability test show that in indicators 1 and 5 there are 53.06% and 40.81% who have metacognitive abilities. The results of the needs analysis are used as the basis for developing electronic modules by integrating metacognitive strategies in the form of analogies, mnemonics, and discrepant events. This research is Research and Development (R&D), this research develops a metacognitive-based e-module that refers to the ADDIE model, in this paper the data obtained from research up to the development stage. The results of the validity test by the validator showed that the metacognitive-based e-module obtained a score of 3.8 with a very valid category. The resulting e-module has the potential to improve students' higher-order thinking skills.

1. Introduction

The 21st century demands highly capable human resources intellectually and skillfully. Educational institutions are required to reform themselves in order to prepare 21st Century Human Resources. Skills that need to be prepared through the implementation of Teaching and Learning Activities include critical thinking, creativity, communication and collaboration, being able to utilize knowledge to solve problems, and various other skills (Syamsiara, 2020). These skills can be formed and improved through a learning process that is not instant and often in its application encounters various obstacles or facts that are not as expected.

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This study will identify factors that become a complicated problem which is an issue of education in higher education. Identification is done through analysis of student needs with the distribution of assessments in the form of multiple-choice questions as many as 15 questions based on metacognitive, critical thinking, and self-regulation. The needs analysis sample consisted of 49 respondents from biology education students, FKIP, Riau University. The results of the needs analysis show that several indicators are still low.

Based on the results of the needs analysis above, it is necessary to improve the quality of education in a comprehensive manner. The learning process especially in higher education is expected to improve higher-order thinking skills and shape individual characters as lifelong learners. This is certainly our hope and task in improving the quality of education. One of the ways to improve the quality of education through the learning process is by developing digital learning resources that are integrated with metacognitive strategies in the form of e-modules. Metacognition is a person's skill in regulating and controlling his thinking process. Someone who has good metacognitive abilities will have good thinking skills as well.

This is relevant to metacognition theory which states that someone who learns will have certain skills to regulate and control what he learns. These skills include problem-solving, decision-making, critical thinking, and creative thinking. The integration of metacognitive strategies into learning tools or teaching materials is an alternative solution that can be applied to the learning process structurally. In this study, a metacognitive-based electronic module will be developed. This study aims to identify and explore metacognitive strategies that can be integrated into electronic modules to improve Higher Order Thinking Skills (HOTS).

2. Methodology

This research is a descriptive study with a Systematic Literature Review (SLR) approach combined with a needs analysis to identify, assess, and interpret all findings related to the research topic. The study begins with a needs analysis with 49 Biology Education students as respondents using a data collection instrument in the form of a metacognitive test distributed online using Google Form in March 2021. The data collected is related to metacognitive abilities which will then be compiled, interpreted, analyzed, and further studied on various factors related to the conditions, situations, and phenomena studied. Descriptive data analysis as the basis for developing learning resources in the form of e-Modules with the ADDIE development model (Jones, 2014). The data obtained from the results of the study reached the analysis stage in this paper.

3. Results and Discussion

Metacognition as a Learning Strategy

The metacognitive essence in learning can be described by how students find the most effective way to learn, know the learning modalities and utilize their abilities, and know the best learning strategies for effective and meaningful learning. Metacognitive is a self-regulation ability to look at oneself so that what is done can be controlled optimally. A person with metacognitive knowledge is able to conduct self-evaluation and is aware of his strengths and limitations in learning. In other words, when someone finds out their mistake, they consciously admit that they were wrong, and try to find a turning point to fix it. The role of educators is needed to train students to have metacognitive abilities and be able to implement them in the learning process so that they can stimulate and improve higher-order thinking skills.

Research on the development of metacognitive-based e-modules, in this paper will describe and discuss the validation results from the field of pedagogics, materials and media validators. The validation results from the pedagogic validators obtained an average of 92.3% with a very valid category. The highest score on indicator 7 indicates that the presentation of the content of different events stimulates students to think critically, is able to place students as learning subjects, the presentation of material is participatory which motivates and is in accordance with the characteristics of the Basic Biology Course. According to Anggoro (2019), discrepant events are information presented to focus attention, stimulate and motivate, and attract students' attention in the learning process.

The average e-module validation results by material experts are 91.92% in the very valid category of all indicators on the aspects of feasibility, presentation and language. This is because, substantially, metacognitive-based e-modules which are integrated with discrepant events, analogies, and mnemonics concepts are able to convey material effectively, leading textbook concepts to contextual learning dimensions. According to Safitri (2018), states that metacognitive analogical reasoning is able to form an abstract schema of a concept for contextual space, thereby increasing the quality of the information transfer process in learning through real contexts. Analogous reasoning is also able to increase competence and a positive response to the implementation of analogy learning in instilling character education.

The average result of e-module validation by media experts is 93.1% in the very valid category of all indicators. This is based on metacognitively that the e-module is in accordance with the standard size, proportional graphics on the front cover page, the synopsis on the back cover is able to provide a general description of the content of the e-module, and the image on the presentation of the content of the e-module is able to clarify the presentation of the material.

Implementation of Metacognitive Strategies in the Learning Process

Implementation of metacognitive strategies in the learning process will help students to be able to obtain long-lasting learning in students' memory and understanding at the level of meaningful learning. Students should be directed to achieve a high level of competence through various innovative learning activities,

one of which is through the implementation of metacognitive strategies. Based on the results of various studies, efforts to improve the quality of the learning process can be carried out, one of which is assisted by the development of learning tools or learning resources that are integrated with metacognitive strategies to improve higher-order thinking skills. This is in line with research by Yuningsih (2018), suggesting that the concept of metacognitive analogy is often associated with reasoning which is part of students' higher-order thinking skills (HOTS) Research by Fuhrmann (2020), states that the effect of applying a metacognitive approach to the concept of discrepant events can increase higher-order thinking skills in students. This statement is also supported by Mujis's research, revealing that the metacognitive approach aims to raise awareness in the context of self-regulation in designing, monitoring, and controlling what is known, what is needed to do it, and how to do it in solving problems (Mujis, 2020).

Furthermore, it can be proven that the higher-order thinking skills of students who have high metacognitive strategies have a statistically significant difference with students who have low metacognitive strategies (Parlan, 2021). Research by Mitsea states that the application of metacognitive, class management and student and teacher activities are good, and instruction of metacognitive learning strategies improved significantly the academic achievement (Mitsea, 2019). Then the results of the research from the application of the analogy strategy state that analogies act as a bridge for understanding the material that is difficult for students to visualize through phenomena/objects around them that are familiar to them. The power of analogy is not limited to material in the form of concepts, but also types of material, processes, and structures. Moreover, the use of analogies in learning makes it difficult for students to forget concepts that have been imprinted in their brains (Yuningsih, 2018). This research is also supported by research by Remigo (2018), which states that the application of analogy models helps students to improve creative thinking skills and to improve reasoning skills in science.

Stage of Analysis for Metacognitive Ability Analysis

The general description of the respondents in this study were active students majoring in Biology Education at FKIP University of Riau. With 42 (85.7%) female respondents and 7 (14.3%) male respondents. The results of the analysis of students' metacognitive abilities can be seen in Table 1.

The results of the metacognitive ability analysis in Table 1 above show that the indicator identifies sources of error from the data obtained by 71% in the medium category. Indicators for designing what will be learned are 53% and indicators for selecting important information used in problem-solving are 41% in the low category. Based on the results of the initial analysis of student needs, it can be concluded that there are several indicators in the medium and low categories that need improvements in the learning process, one of which can be assisted through the development of teaching materials that have the potential to improve these abilities.

Table 1. Analysis of Student Metacognitive Ability

No.	Indicators	Metacognitive Ability	
		Able n (%)	Not Able n (%)
1	Organizing their study	26 (53.06)	23 (46.94)
2	Knowing that the elaboration strategy improves understanding comprehension	48 (97.96)	1 (2, 04)
3	Identify the sources of errors from the data obtained	35 (71.42)	14 (28.57)
4	Applying experience to new situations	46 (93,87)	3 (6.12)
5	Selecting important information used in problem solving	20 (40.81)	29 (59.18)

Syllabus Analysis

This metacognitive-based E-module is based on the sub-CPMK and cell, plant, and animal tissue learning materials contained in the Basic Biology Course syllabus. Based on the categorization of learning Outcomes Course (CPMK), it can be concluded that: 1) students are required to have high-level thinking skills qualifications to be able to achieve optimally CPMK and sub-CPMK that have been formulated in the syllabus, 2) cell and tissue material is substantially microscopic and difficult to visualize, so it requires teaching materials that can visualize microscopic material through pictures and videos. 3) video content can only be integrated into electronic-based teaching materials. Based on this syllabus analysis, the researchers chose electronic teaching materials based on metacognitive modules to improve thinking ability higher-order.

Analysis of Teaching

Materials The teaching materials developed in this research are electronic modules (e-modules). The selection of e-modules is due to dynamic learning demands and refers to its advantages, including interactive (can display images, audio, video, feedback through formative tests, etc.), organize for independent study *online* and *offline*, 3) guide individual investigations as well as groups. The advantages of e-modules are as an alternative solution for learning materials that substantially need to be visualized such as cell and tissue material in Basic Biology Courses. Based on open interviews with the research sample, it was found that there were no teaching materials in the form of e-modules based on metacognitive strategies as independent teaching materials given to students.

The determination of the integration of metacognitive strategies into the characteristics of the e-modules that have been developed because of referring to the relevance of the analysis of the needs for the development of teaching materials that have been described in the data above. The data shows that students' metacognitive abilities are still low. This implies the need for innovation in the development of e-module teaching materials based on metacognitive strategies. The integrated metacognitive strategies are *discrepant events*, analogies, and mnemonics. Metacognition is a dimension *advanced* of a person's cognitive level. In other words, if someone has good or high metacognitive abilities, then that

person should also have good abilities in high-level thinking such as critical thinking skills and self-regulation.

Metacognitive-based E-Module Design Stage

Several metacognitive strategies are integrated into the module in the form of analogies as Figure 1, mnemonics as Figure 2, and discrepant events as Figure 3.

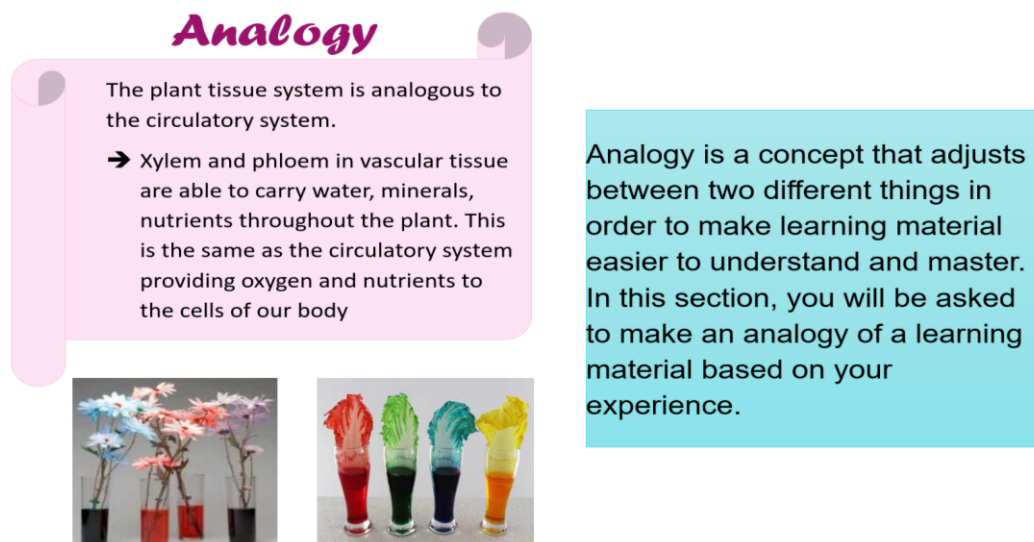


Figure 1. Example of Application of Analogy in e-Module

The use of analogy victorials in physics learning can improve understanding of the concept of an average pre-test of 55.4 and post-test of 77.0 the use of analogies can also reduce misconceptions (Djudin, 2019).

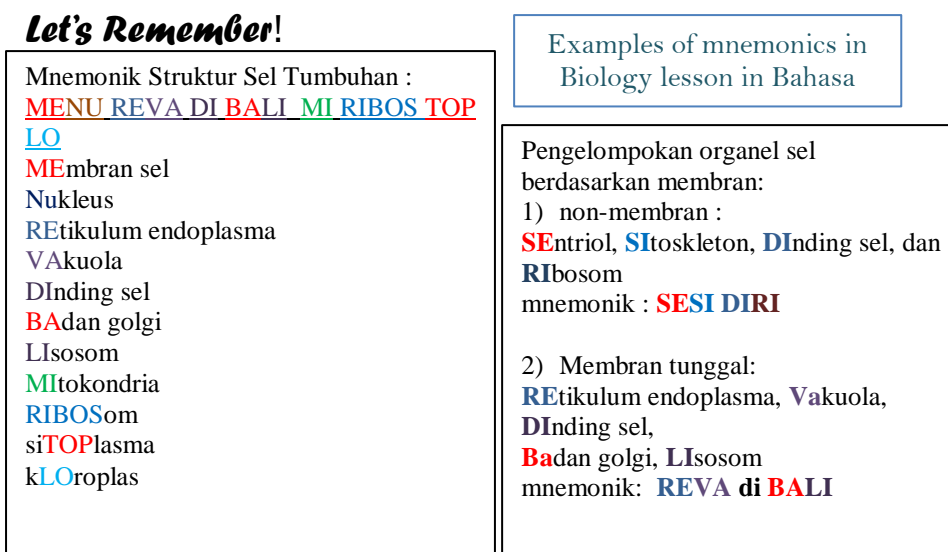


Figure 2. Example of Application of Mnemonics in e-Module

Lubin (2016), used the mnemonic CAMSEA for the acronym of Cnidarians, Annelids, Mollusks, Sponges, Echinoderm, Arthropods.

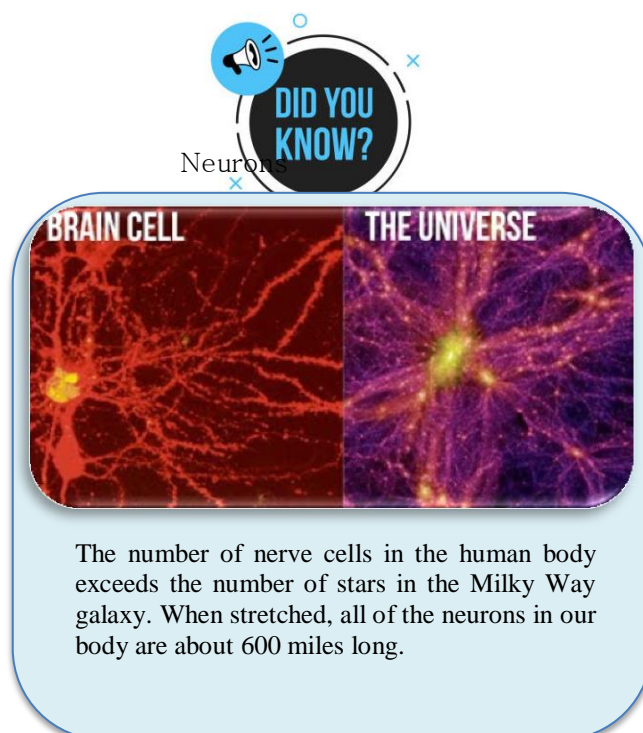


Figure 3. Example of the Application of *Discrepant Events* in e-Modul

Anggoro (2019), stated that designing Discrepant Events can make abstract concepts concrete (make the Invisible Visible). Metacognitive strategies can improve HOTS thinking skills. Higher-order thinking skills, especially metacognition, are crucial abilities that must be possessed by someone to achieve success in learning, or on a broader scale, namely achieving success in life. Metacognition means thinking about the object of thought (thoughts) and is an activity consisting of a process of self-evaluation of the cognitive stage, designing, organizing strategies, and assessing the implementation of the tasks performed. The higher a person's metacognitive ability, the higher the level of learning success. The level of success of a person's learning can be influenced by the learning experience. When a learner has adequate metacognitive abilities, he will be able to carry out his learning process better to obtain better results.

Electronic-Modul Development Stage the Metacognitive-Based

Electronic-module that has been developed was then validated by 5 validators who are experts in pedagogics, material experts, and media experts. The results of the recapitulation of metacognitive-based e-module validation can be seen in Table 2.

Table 2. E-module Validation Results Recapitulation

No.	Field of validation	Average	Category
1	Pedagogical Expert	3.9	Very Valid
2	Material Expert	3.6	Very Valid
3	Media Expert	3.8	Very Valid
	Total	3.8	Very Valid

Based on the validation results from pedagogical experts, the metacognitive-based e-module got a score of 3.9, meaning that the overall feasibility of the e-module content from a pedagogical perspective is very valid and has the potential to form students' higher-order thinking skills. Validated indicators on the aspect of content feasibility include: 1) the suitability of the material with sub-CPMK, 2) the relationship between concepts, 3) the suitability of the image with the material, 4) *discrepant events* stimulate critical thinking, 5) analogy accuracy, 6) analogy stimulates thinking critical, 7) *discrepant events* stimulate self-regulation, 8) analogies stimulate self-regulation, 9) mnemonics according to the material, 10) mnemonics stimulate self-regulation, 11) materials place students as learning subjects, 12) student involvement, and 13) suitability of approach and methods with courses.

The results of the validation from material experts, metacognitive-based e-modules got a score of 3.6, meaning that metacognitive-based e-modules are very valid from the aspects of the feasibility of content, presentation, and language. Indicators on the aspect of content feasibility include: 1) achievement of sub-CPMK, 2) *discrepant events* stimulate critical thinking, 3) analogies stimulate critical thinking, 4) *discrepant events* stimulate self-regulation, 5) analogies stimulate self-regulation, and 6) mnemonics stimulate self-regulation. Indicators on the feasibility aspect of presentation include: 1) introduction to e-modules, 2) questions to stimulate critical thinking, 3) questions to stimulate self-regulation, 4) student involvement, 5) glossary presentation and 6) bibliography presentation. Indicators on aspects of linguistic feasibility include 1) accuracy and effectiveness of sentences, 2) standardization of terms and 3) language interest.

The validation results from the metacognitive-based e-module media experts got a score of 3.8, meaning that the metacognitive-based e-module is very valid from the aspect of graphic feasibility. Indicators on the graphic feasibility aspect include: 1) e-module size, 2) layout, color combinations, illustrations, and typography on the *cover*, 3) proportional size, 4) synopsis on *the cover* back, 5) image illustration *cover*, 6) layout of titles, subtitles, introductions, table of contents, illustrations, and material content, 7) clear separation between paragraphs, 8) illustrations and descriptions of images in the contents of the e-module, and 9) ease of use and accessibility. The average metacognitive-based e-module validation scored 3.8 with a very valid category, meaning that the metacognitive-based e-module is ready to be used on a wider scale and has the potential to improve students' higher-order thinking skills.

4. Conclusion

The integration of metacognitive strategies in the development of learning resources in the form of e-Modules has the potential to improve higher-order thinking skills. The developed metacognitive strategies include analogies, mnemonics, and discrepant events. The features in the e-Module plus a concept map and Let's Think facilitate students to learn and manage their learning independently. Recapitulation of assessment results from pedagogic experts, material experts, and media experts, metacognitive-based e-modules on cell and tissue material obtained an average score of 3.8 with a very valid category. Based on the results of the research, it can be concluded that metacognitive-based e-modules are ready to be used on a wider scale and have the potential to improve students' higher-order thinking skills.

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