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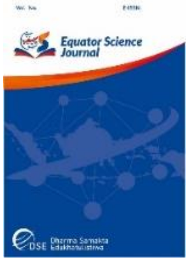

The Effect of Mobile Learning on Excretion System Materials on Cognitive Load and Student Concept Mastery

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ABSTRACT
The fast development of internet and mobile technologies prompt this study. Mobile learning technology is accessible and convenient, as students can use advantageous devices to acquire knowledge at any time and location. Mobile learning can effectively meet students' educational requirements in acquiring knowledge. Furthermore, the design of learning materials that are inappropriate for mobile learning might be attributed to one of the reasons of students' cognitive stress. The purpose of this study is to see how mobile learning (Edmodo) on excretory system content affects cognitive load and student concept mastering. This research used a quasi-experimental method consisting of two classes: the experimental class (using mobile learning) and the control class (conventional learning). The instrument used to measure cognitive load consisted of questionnaires of intrinsic cognitive load, extraneous cognitive, and germane cognitive load, while the instrument for mastery of concepts consisted of pre-test and post-test. In addition, there was also a student response questionnaire to review the use of mobile learning in the experimental class. The data that had been collected were analyzed by a descriptive statistic method using SPSS 25.0. The results show that students in both classes have a cognitive load that can be controlled, but the cognitive load in the experimental class was more controllable than in the control class. The result of mastery of concept showed that the experimental class was higher than the control class, with a post-test significance value of 0.001 <0.05. Thus, it can be concluded

that mobile learning influence the excretory system material on the cognitive load and mastery of students' concepts.

INTRODUCTION

With the advancement of the internet and mobile technologies, mobile learning, or mobile learning, has grown significantly. Students may learn at any time and from any location using mobile devices. Aside from that, the mobile learning process encourages students to discover themselves and study autonomously (Ahmad et al., 2021). Mobile learning, also known as learning using mobile devices (Wang et al., 2018; Tabuenca et al., 2015; Luarn et al., 2006), can be utilized to suit students' learning goals in knowledge acquisition (Wang et al., 2018; Chen et al., 2003). Mobile learning may deliver more appealing learning materials and instructions through imagery (Mu'aziyah et al., 2023). According to Nasution (2016) research, pupils who learn utilizing multimedia or technological facilities are more motivated than those who learn in traditional classroom settings.

Many technology-based media, like Edmodo, may be utilized to assist mobile learning. Edmodo is a secure and user-friendly learning platform for both teachers and students. Edmodo includes numerous elements that can help with mobile learning, such as the ability to communicate or connect with other students and teachers (Gunawan et al., 2023). Students and teachers can also exchange materials in the form of books, videos, photographs, links, and polls (Muzdalifah & Ismail, 2023). Aside from that, Edmodo may be used to offer tasks, quizzes, and grades at the end of each class.

Mobile learning offers convenient and rapid access to educational content, enabling students to learn autonomously based on their own pace and preferred learning methods. Improper design of learning materials in mobile learning might be regarded as one of the reasons of students' cognitive overload (Curum & Khedo, 2021; Chu, 2014). Examples include delivering excessively difficult content, too many concepts and facts that do not align with the learning objectives, and utilizing new language (Kennedy, 2021). This may have a detrimental impact on kids' intrinsic load. Because the complexity of the tasks or activities that students perform increases the intrinsic load put on them (Brünken et al., 2010).

Excretory system content in the Biology topic in high school class XI is one of the resources that students must study according to the Indonesian curriculum for 2013. This content contains a number of mechanisms, such as the mechanism of urine creation; however, because the information is abstract, it will be simpler to understand if it is supplemented with photos, illustrations, and video animation. Providing information about a sequence of procedures without visuals, graphics, or video animation will raise superfluous cognitive strain (Fatoni et al., 2022; Kennedy, 2021).

Given the numerous factors that can influence students' cognitive load and the benefits of using mobile learning to learn excretory system material, a study was conducted to assess students' cognitive load and mastery of concepts using mobile learning in class XI high school excretory system material.

Mobile learning is defined as learning that uses gadgets to allow students to access learning materials, instructions, and apps anywhere and whenever they choose (Warsita, 2010). According to certain study, mobile applications that give students with assistance and recommendations for observing learning items might help them obtain better results. A research conducted by (Hochberg et al., 2020) explored the link between mobile devices as an experimental tool and learning accomplishment, interest, and curiosity. The findings revealed that mobile devices as an experimental tool greatly boosted student learning achievement.

A variety of factors must be considered while developing mobile learning apps. One of them is how the program is packaged as little as possible, allowing students to utilize it for learning through a thin monitor layer (Warsita, 2010). There are several learning media technologies in the form of platforms that are employed in all educational institutions, both at the school and university levels, to improve the learning process. Examples include Google Classroom, E-learning, YouTube, Whatsapp Group, Edmodo, Zoom, Google meet, and other services that promote mobile learning. Edmodo is a safe, free, and simple internet-based learning platform that allows teachers to organize and administer virtual courses, allowing students to connect with classmates and teachers at any time and from any location. The Edmodo application includes a functionality that allows teachers to form small groups based on pre-established instructions. Students who are part of small cohorts have the opportunity to access several assignments provided by the instructor. The tasks assigned to these small groups can be formulated in a manner that facilitates the smooth progression of each group's discussion process. Nicolas Borg and Jeff O'Hara created Edmodo as a learning platform that allows students and instructors to collaborate and communicate by sharing educational information, organizing projects or assignments, and handling notifications for each action. Edmodo includes a variety of learning activities to help students learn, including quizzes, assignments, polls, grade books, libraries, reward badges, and parent codes.

Cognitive load theory applies to complicated learning activities in which pupils struggle with the amount of information presented and must process at the same time. The total cognitive load encountered when learning is the sum of the three categories of cognitive burden that surpass humans' working memory capacity (Desi et al., 2023; Park & Brünken, 2015). According to the triarchic cognitive load theory model derived from Moreno and Park (2010) in the paper (Park & Brünken, 2015), total working memory capacity includes free capacity, intrinsic cognitive load (ICL), extraneous cognitive load (ECL), and germane cognitive load (GCL).

The intrinsic cognitive load component is proportional to the complexity of the subject or material under study. ICL refers to the process of receiving and processing information (MMI) acquired throughout the learning process. The Extraneous Cognitive strain component represents cognitive strain that is indirectly connected to learning and is induced by instructional load. This load is connected to the mental work used by pupils throughout the learning process. The fourth component is Germane Cognitive Load, which is determined by student learning outcomes resulting from internal and extrinsic load. Cognitive load is defined as the overall amount of strain placed on a learner's mental faculties during study. Meaningful learning requires cognitive processes (Henukh et al., 2023; Curum & Khedo, 2021). According to Cognitive Load Theory, learning occurs when information received by one of the senses is processed in working memory and transported to long-term memory for storage and reuse when needed (Kennedy, 2021).

Every instructor must pay attention to students' conceptual knowledge once a lesson has been completed. According to Anderson et al (2004) in the Mufidah & Diantoro (2020) article, if a student is able to construct the meaning of learning material in the form of verbal, written, graphic, and understanding of the material based on experience or prior knowledge, then the student has understood a concept. Concept mastery refers to a student's capacity to utilize previously taught concepts to grasp new concepts or solve problems (Astuti, 2017). This study's concept mastery is tested using Bloom's taxonomy, which includes remembering (C1), understanding (C2), applying (C3), and analyzing (C4).

The study by Hochberg et al (2020) examined the impact of using mobile devices as an experimental tool on learning accomplishment, interest, and curiosity. The findings indicate that using mobile devices as an experimental tool considerably positively affects student learning achievement. Additional research findings indicate that students who engage in multimedia or technology-based learning methods exhibit higher motivation levels than those who engage in traditional learning methods (Supriyadi et al., 2018; Nasution, 2016). Mobile learning is expected to impact students' acquisition of concepts positively. This article contains a number of processes, including the creation of urine and perspiration. As a result, learning via mobile devices is required.

METHOD

The research method used is experimental, namely a quasi-experiment using a quantitative approach. The researchers provide therapy to participants during educational exercises focused on the excretory system to examine the impact of mobile learning on students' cognitive load and comprehension of concepts. Quantitative research involves collecting numerical or statistical data, subsequently evaluated using quantitative methods (Creswell, 2009). The Purposive Sampling approach was utilized in this study. Purposive sampling is a method researchers use to choose participants or sample units based on specific traits deemed necessary for the research goals (Creswell, 2009). The experimental and control classes were chosen based on the following criteria: they were high school students in class XI Science, possessed mobile devices, and could connect to the internet. The experimental class received treatment for learning procedures, specifically mobile learning using the Edmodo application, whereas the control class received conventional learning procedures (without the Edmodo application) and only used learning media in the form of PowerPoint presentations with teacher explanations. Two meetings are required for this research.

The Edmodo LMS (Learning Management System) application is used in this study's mobile learning to direct students toward their learning objectives. Students will fill out an observation sheet in the form of a questionnaire or opinion questionnaire to help examine this mobile learning design. Cognitive load is an unbalanced relationship between cognitive load components, these components consist of Intrinsic Cognitive Load (ICL) described from the results of students' scores in filling out initial knowledge test instruments related to understanding the material before learning, Extraneous Cognitive Load (ECL) described from the results of students' scores in fill out the questionnaire instrument at each meeting after learning, and Germane Cognitive Load (GCL) is described from the results of students' scores in filling out the final knowledge test instrument which is carried out after learning. The three elements of cognitive load are expressed as a subjective rating scale statement using a 4-point Likert scale. The total score is classified as a total score between 30 and 39 is considered "failed," between 40 and 55 is considered "incompetent," between 56 and 65 is considered "fair," between 66 and 79 is considered "competent," and between 80 and 100 is considered "very good" (Arikunto, 2013). Concept mastery data collection was carried out by filling in the pretest instrument at the beginning of the meeting and the posttest at the end of the meeting.

The cognitive load and concept mastery instruments were analyzed using Microsoft Excel to find percentages, average values and scores. To determine the differences in cognitive load components and concept mastery in classes that use mobile learning and conventional classes, in both classes (experimental and control) a normality test was carried out and a homogeneity test was also carried out in SPSS 25.0. If the data follows a normal distribution, it is analyzed using a parametric T-test. If the data does not follow a normal distribution, it is analyzed using a non-parametric test called the Mann-Whitney U test $\alpha = 0.05$. Then, to determine whether there is cognitive load in the two classes, an analysis of the average value of each component of cognitive load is carried out based on the cognitive load theory put forward by Meissner & Bogner (2013) (in the article by (Rahmat & Hindriana, 2014)) that the learning design used good is learning that is learning that can provide tasks that can reach a sufficient and not excessive level of ICL, is able to reduce ECL, and is able to increase GCL.

RESULTS AND DISCUSSIONS

Cognitive Load Analysis

The data obtained from the measurement results of each cognitive load component were converted to a scale of 100. The measurement results of the three components can be seen from Table 1.

Table 1. Average Value of Cognitive Load Components

Components of Cognitive Load	Average Value			
	Experimental class	Criteria	Control class	Criteria
ICL	40	Incompetent	42	Incompetent
ECL	39	Incompetent	49	Incompetent
GCL	85	Competent	76	Competent

According to Table 1, the Germane Cognitive Load (GCL) component yielded the highest score for both the experimental and control groups. However, when comparing the two groups, the experimental group's GCL score and value was greater. The ICL (intrinsic cognitive load) and ECL (extraneous cognitive load) scores in the experimental class were lower than the control class.

Students' ICL levels vary depending on their background knowledge. Students' ability to relate new information to the knowledge they already have describes the magnitude of ICL (Smith & Johnson, 2019). Based on Table 1, it is known that the average value and score on the ICL of students in the experimental class is smaller than that in the control class. This shows that the ICL of students in the experimental class is lower than the control class, or it can be concluded that the ICL of the experimental class and control class is categorized as incompetent, in accordance with the provisions (Arikunto, 2013).

The ECL questionnaire was created in accordance with the learning strategy to determine the mental effort or difficulty felt by students in receiving and processing information during the learning process. In Table 1 it can be seen that the average ECL score of students in the experimental class is smaller than the control class. This shows that the ECL of students in the experimental class is lower than the control class, or it can be concluded that the ECL of the experimental class and control class is categorized as incompetent, in accordance with the provisions (Arikunto, 2013).

The GCL questionnaire was created in accordance with core competencies and basic competencies which were developed developed to evaluate the retention of relevant knowledge and how students are able to carry out analysis on the information received during learning. In table 1, it is known that the GCL of the experimental class and control class is categorized as competent, in accordance with the provisions (Arikunto, 2013). However, the average grades and scores on the GCL of students in the experimental class were greater than those in the control class. This shows that the GCL of students in the experimental class is higher than the control class.

The Influence of Mobile Learning on Excretory System Material on Concept Mastery

Based on the cognitive load theory put forward by Meissner & Bogner (2013) (in article Rahmat & Hindriana, 2014) that good learning design is learning that is able to provide tasks that can achieve sufficient and not excessive ICL levels, is able to reduce ECL, and is able to increase GCL. In line with this theory, it can be concluded that the indicator for students being cognitively burdened is if the ICL and ECL scores are greater than the GCL. However, if the ICL and ECL are smaller than the GCL, then the student is not cognitively burdened. It emphasizes the significance of maximizing GCL while decreasing ICL and ECL in the design of efficient learning (Van Merriënboer & Sweller, 2010). The research findings from the study conducted by (Doe & Smith, 2018) indicate that enhancing GCL while reducing ICL and ECL might enhance the efficacy of instructional methods in learning environments.

The statistical results on ICL show that there is no difference between the experimental and control classes with a significance of 0.567 ($p < 0.05$), but on the ECL and GCL the statistical results show that there is a difference between the experimental and control classes with a significance of 0.001 ($p < 0.05$). Based on the statistical results on the ICL for the experimental class and control class, it shows that the two classes have equivalent initial knowledge.

The average ICL and ECL scores in both classes are classified as incompetent, while the average GCL scores in both classes are classified as competent. It can be concluded that based on the average scores of the two classes, students do not appear to be cognitively burdened. However, if you look at the magnitude of the values, the experimental class has lower ICL and ECL values than the control class and the experimental class has higher GCL values than the control class. It can be concluded that the experimental class is better than the control class as evidenced by the significant differences in ECL and GCL values. This is in line with research by (Hochberg et al., 2020) which investigated the relationship between mobile devices as an experimental tool on learning achievement, interest and curiosity. The results showed that mobile devices as an experimental tool significantly increased student learning achievement.

According to (de Jong, 2010), ICL in the learning process is the ability to receive and process student information. If a student has a low ICL, then the student has a high ability to receive and process information. Based on these results, it shows that learning using mobile learning does not cause difficulties for students in processing and receiving information regarding excretory system material.

The average ECL value in the experimental class is lower than the control class. Students in the experimental class showed lower extraneous burden resulting from learning activities compared to the control class. In the experimental class, abstract excretory system learning material was explained using video illustrations that could be played repeatedly, whereas in the control class only used narration and videos that were only shown once in front of the class. This is in line with the opinion of (Kennedy, 2021), that presenting information on a series of processes without images or illustrations and/or video animations will increase extraneous cognitive load (*extraneous cognitive load*). ECL burden can also be imposed when students have to integrate information sources distributed over a place or time, or when they have to search for information needed to complete a learning task, then this will happen *overload* (Kennedy, 2021).

The average GCL value in the experimental class is higher than the control class. This is in line with the opinion of (Kennedy, 2021), that GCL is the processing needed to organize the material being studied by connecting existing schemes in long-term memory or in other words GCL is influenced by students' motivation to study the material and the background knowledge they have. So if a student has a high GCL, it can be concluded that the student is able to reconstruct the material he is studying with the initial knowledge he has and has high motivation in studying the material (Brown & Jones, 2020)**.**

Students in the experimental class outperformed students in the control class in recreating the material of the excretory system, as previously indicated. Students in the experimental class employ mobile learning, where they frequently use their mobile devices as communication tools. Students are more driven to finish the assignments provided by the teacher when they use mobile devices for learning. Based on the responses to the answer questionnaire, every student in the experimental group reported that they were not bored with the excretion system learning activity sheet assignments.

Analysis of Concept Mastery

Table 2 displays the pretest and posttest results for the experimental class and the control class.

Table 2. Average Value and N-Gain of Students' Concept Mastery

Class	Pretest	Posttest	*N-Gain*	Criteria	Interpretation
Experiment	44	82	0,66	Moderate	Sufficiently Effective
Control	46	71	0,46	Moderate	Less Effective

Table 2 shows that there is little difference in the control and experimental classes' average pretest scores for concept mastery. In the control class, the average pretest score was forty-six. Of the students, eighteen scored higher than average, and seventeen scored lower than normal. There were 25 students in the experimental class who scored higher than the average (pretest mean of 44), and 10 students who scored lower than the average. Following instruction, the experimental class's average posttest score was greater than the control class's, with an 11-point difference between the two classes' average scores. In the control group, the mean posttest score was 71. Of the pupils, 18 scored higher than the mean, while the remaining 17 scored lower. Within the experimental class, the average posttest score was 82. Of the students, 15 scored more than average, while the remaining 20 scored lower than normal.

Further, in order to examine the direction of effect and provide evidence for the impact of mobile learning on concept mastery, N-Gain testing was conducted. According to the experimental class's N-Gain computation, which came out to be 0.66, there was an improvement in pretest and posttest scores with modest criteria. This suggests that using mobile learning to improve concept mastery can be a successful strategy. The control group's N-Gain was 0.46, indicating a rise in pretest and posttest scores with modest criteria. This suggests that traditional learning methods are not as successful in improving concept mastery. These findings align with the research conducted by (Hochberg et al., 2020), which demonstrates that mobile devices have a substantial positive impact on students' academic performance.

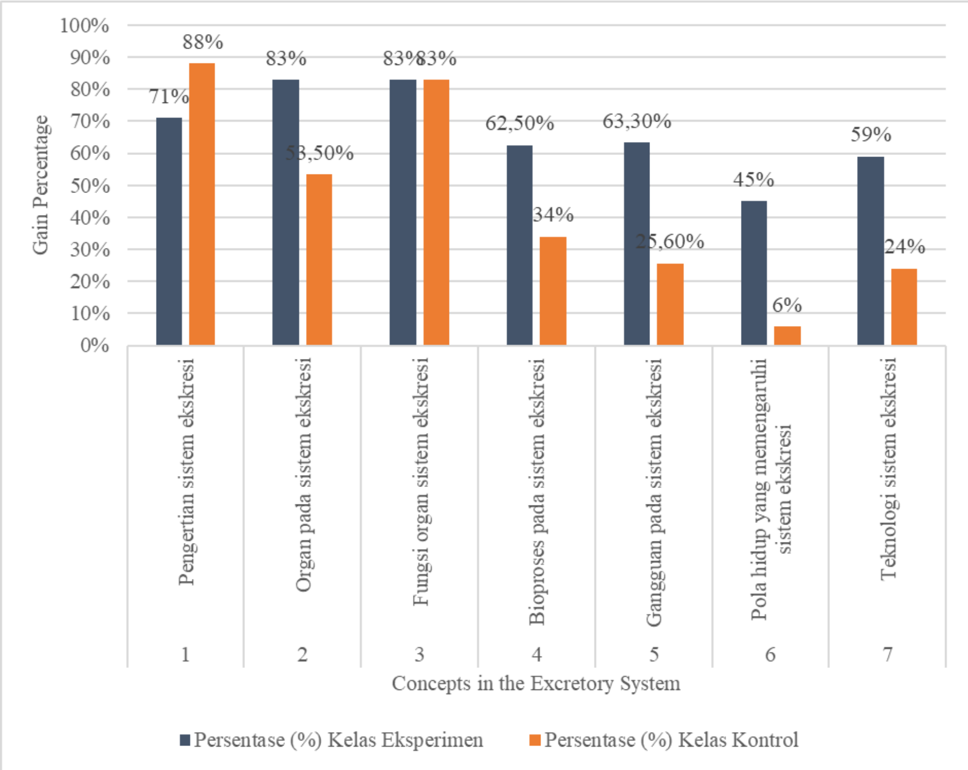

Fig 1. Percentage of Gain for Each Excretory System Material Concept

Figure 1 illustrates that, in comparison to the control class, the experimental class's average proportion of pupils who have mastered the idea is higher. The idea pertaining to the meaning of the excretory system demonstrated the greatest percentage in the experimental class (88%), whereas the concept pertaining to the organs' function in the control class demonstrated the highest percentage (83%). Understanding how lifestyle affects the excretory system was the notion that demonstrated the lowest percentage in both the experimental and control groups.

The Influence of Mobile Learning on Excretory System Material on Concept Mastery

The results obtained from processing the Mann-Whitney U test data with the help of SPSS 25.0 software show the data in Table 3.

Table 2. Average Value and N-Gain of Students' Concept Mastery

Test Phase	Pretest	Posttest
Mann-Whitney U	564.500	241.000
Asymp. Sig (2-tailed)	0,565	0,001

In this study, a significance level of 0.05 was used. The significance value of the pretest data is 0.565 > 0.05, so H_0 is accepted. This means that students' ability to master initial concepts in the experimental class and control class is not significantly different. The significance value of the posttest data is 0.001 <0.05, then H_1 is accepted. This means that students' ability to master concepts after being given treatment has a significant difference between the experimental class and the control class. In other words, there is an influence of implementing mobile learning on students' mastery of concepts.

Mastery of concepts in both classes, namely the experimental class and the control class, based on statistical results, shows a significant difference in the posttest scores. In other words, there are differences in students' understanding results after learning. The average pretest and posttest scores in Table 3 show that the average pretest scores for both classes are the same and the posttest scores in the experimental class are higher than the control class. This is in line with research conducted by (van Es et al., 2014), that the use of mobile learning that contains videos can improve the discussion process which can influence students' mastery of concepts. The videos contained in mobile learning are different from those that are only played in front of the teacher, the videos contained in mobile learning can be played many times so that students can easily understand the processes that occur in the video animation.

Feng et al., (2018) conducted multiple research studies to examine the impact of mobile learning on students' comprehension of ideas. Their meta-analysis study specifically focused on investigating how mobile learning affects students' learning experiences and outcomes. The findings indicate that mobile learning has a substantial and beneficial effect on students' comprehension and command of ideas. Additional research suggests that educational applications tailored for mobile platforms can offer convenient and rapid access to learning content, present information in a stimulating and interactive manner, and promote self-directed learning. Furthermore, the use of instructional films, simulations, and interactive quizzes in mobile learning can enhance student engagement and facilitate comprehension of intricate concepts (Traxler & Kulkulska-Hulme, 2005).

Before starting teaching in the experimental class, the teacher initiates class conditioning by presenting visual stimuli and engaging students in discussions on the colour of urine. Similarly, in the control class, the distinction lies in not all students engaged in the conversation (just a select few students were actively involved). Nevertheless, in the experimental class, nearly all students discussed the hue of urine. Engaging in discussion activities related to these stimuli can influence mastery of concepts. Gunawan et al. (2016) and (Mufidah & Diantoro, 2020) argue that students' comprehension of topics will be more robust if they receive adequate class preparation or conditioning prior to learning. The post-test results provide evidence that the experimental class pupils have greater mastery of ideas compared to the control class.

CONCLUSION AND SUGGESTION

Students in both classrooms have a controllable cognitive load, meaning that mobile learning has an impact on their cognitive load. This is predicated on the average GCL scores for the two courses that are categorized as good and the average ICL and ECL scores for the two classes that are classed as bad. The average GCL value in the experimental class, however, is higher than the control class when comparing the average values of the cognitive load components between the two classes. This indicates that students are better able to process cognitive schemes with new information through learning that uses mobile learning. The statistical results on ICL indicate that there is no difference ($p < 0.05$) between the experimental and control classes; however, the statistical results on ECL and GCL indicate that there is a difference ($p < 0.05$) between the experimental and control classes.

The use of mobile learning has an impact on students' conceptual mastery, as evidenced by posttest data with a significant value of $0.001 < 0.05$. This indicates that there is a notable distinction between the experimental class's and the control class's conceptual mastery following treatment. The average value indicates that the experimental class outperforms the control class.

Utilizing mobile learning for teaching excretory system content can facilitate the delivery of packed material through an application, simplifying the process for teachers. Mobile learning media can be employed as an alternative to teaching excretory system topics in the Indonesian 2013 curriculum, alleviating cognitive stress on pupils. Mobile learning media can be used to enhance students' understanding of the excretory system and improve their mastery of related concepts.

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