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AI-Edmodo E-Learning in Physics Learning: A Study of Students' Cognitive Ability on the Topic of Work and Energy

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ABSTRACT

Teachers have used various ways to explore innovative learning to improve students' cognitive physics skills. Edmodo is a free and secure educational learning network that provides a simple way for teachers to create and manage online classroom communities. This study aimed to analyze the effect of the Edmodo application in improving students' cognitive abilities in physics on the topic of work and energy. The analysis of this study focused on cognitive abilities and student motivation in the classroom. The method used in this research is a quasi-experiment with a pretest-posttest design using descriptive research type that aims to describe the situation/symptom or phenomenon, which is designed to obtain information in the current state. In this case, the improvement of students' cognitive abilities can be seen by using the Edmodo application. The research design used is One Group Pretest-Posttest Design. The sample in this study was class 10 in the Science department, with a total of 27 students using a random sampling technique. Data collection was done by using a physics cognitive ability test. Quantitative data of this study were obtained through objective tests (pretest-posttest) based on Bloom's Taxonomy. The results of this study indicate that the application of Edmodo can improve students' cognitive abilities in physics. With the increase in students' physics cognitive abilities in learning, the learning outcomes of previously low students increased significantly. Therefore, it is recommended that AI-Edmodo improve students' physics cognitive abilities in learning physics on the topic of work and energy.

INTRODUCTION

In the 21st century, a rapidly changing world requires new approaches to fostering higher-order cognitive skills such as critical thinking, metacognition, and deep conceptual understanding [1]. Several recent studies have shown that more than scientific content is needed to understand the topic thoroughly [2]. Instead, it is important to delve into a deeper conceptual understanding of the content, acquire skills specific to it, and be aware of one's knowledge of it [3]. In addition, to make it easier for students to learn physics materials and increase their learning motivation, physics teachers need to apply various teaching strategies [4]. Physics is essential for technological advancement in every country, and its applications can be found in every aspect of human life. For example, in the UK, Physics-based businesses account for 8.5% of the UK's economic output and employ dozens of people [5]. Physics-based sectors play an essential role in generating economic growth and prosperity. When looking at export revenue, the US comes out on top, followed by Italy, the UK, and finally Ireland [6]. Emerging economies such as China, Russia, South Korea, Brazil, and Singapore have grown rapidly due to advances in Science and Technology [7]. Physics is also the cornerstone of scientific inquiry, where there are several problems in learning, especially in secondary schools. Several problems are found, such as the lack of skilled scientific instructors, inadequate teaching resources, and poor educational methods [8]. There is no improvement in the cognitive physics outcomes of secondary school students. This can be seen in the study of physics in Nigeria in 2006 and 2020; the proportion of students who passed high school was only below 50% [9]. In addition, South African studies show that up to 75% of students have low science and math performance [10]. The same condition is also shown in Ethiopia, where physics as a field of study is not emphasized, and many students show low interest [11]. It is not unusual to observe low enrollment rates in physics at the college and university level. Applicants assigned to physics departments are also low achievers [12]. Furthermore, students often have poor prior knowledge; learners and teachers have poor skills needed in teaching and learning, and time is used ineffectively due to a lack of teaching activities. Studies of physics learning from 1970 to the present have found problems and difficulties in learning and understanding physics, ranging from high school to university level. These problems are standard worldwide, independent of culture, government, or topography, and students in the US, Europe, or Asia experience the same problems [13]. Student interest in physics is currently an important issue for effective learning and teaching in many countries. In Georgia, girls show a higher interest in physics than boys [14]. Research findings suggest that physics misconceptions are deeply rooted and result from students' misinterpreting everyday experiences and incorrect observations. As a result, traditional instruction cannot improve students' conceptual understanding and appreciation of physics [15].

Correct conceptions are crucial as they help children remember, retain, and recall concepts. As a result, research shows that students can often retain different physical science ideas that are often incompatible with correct scientific principles and theories [16]. Students' alternative conceptions are used as a starting point for advanced learning, and recent research has focused on students' alternative ideas [17]. Students gain a better awareness of the independence of concepts and the world around them when they have a concrete understanding of the material [18]. Students with a concrete understanding of physics can tackle problems conceptually and culturally without memorizing formulas, which ensures their overall success [19]. Several studies have explored the relationship between the cognitive and affective domains to explain cognitive processes and conceptual understanding. Affective constructs play a role in supporting students' conceptual change [20]. Beliefs, in particular, have been suggested as an essential research topic in science education, as beliefs have been considered one of the psychological constructs that explain cognitive processes [21]. Physics is the science of matter, motion, and energy. Its laws are usually expressed in the language of mathematics. As a science, physics requires specific skills to understand concepts and ideas, such as understanding graphs, which is one of the skills scientists must have to visualize patterns and spot trends [22]. Graphs of kinematics variables - position, velocity, and acceleration - are essential in physics and math courses [23]. Understanding these concepts builds a strong foundation for success as physics concepts become more abstract and more complicated to model mathematically [24]. The topic of work and energy in physics is still complex for students [24]. Study results show that STEAM education positively impacts students' conceptual understanding and reduces or changes the number of misconceptions [25].

Today's learners must overcome these difficulties by applying methods that are considered effective in overcoming these problems. Educators are now looking for ways to personalize learning using video, digital simulations, and computer games [26]. Educators worldwide participate in virtual communities, social media sites, and online networks for support and ideas to improve their practice. Many researchers have explored how and why teachers participate in these online spaces; however, research on how participation can affect teaching and learning is limited [27]. The findings for the first question showed that 70.4% of prospective teachers favored online learning [28]. In 2013, Arne Duncan, US Secretary of Education, designated October as Connected Educators Month to encourage more teachers to participate in online communities of practice to learn, share, and collaborate with teachers globally. The Department of Education Office of Educational Technology (OET) (2010), Tech & Learning (2011), International Society for Technology in Education (2012), and Center for Teaching Quality (2013) recommend that all teachers utilize online communities of practice for ongoing learning and professional growth opportunities [29]. Teachers are constantly pressured to improve their skills and knowledge and, ultimately, to improve student achievement [30]. Over the past decade, many teachers have turned to informal, teacher-run online spaces, such as Edmodo subject communities, to find and exchange professional knowledge to help them develop their practice [30]. These bottom-up online communities and networks are an important source of professional development . Edmodo is a social networking tool that provides a safe space for teachers and students to connect, collaborate, and learn. Teachers commonly use it as a learning management system. However, one of the hidden gems in Edmodo is the "subject community" feature that allows teachers to discover and share subject-specific practice-based knowledge with thousands of members. In the last 5 years, membership in many of these communities has grown to over 500,000. Although some Edmodo subject communities have over half a million members, very little research has addressed the impact of engagement in these online spaces on teaching and learning [31]. Some researchers have examined teacher and student participation in Edmodo class groups and found that these spaces support collaborative peer-to-peer learning and reflection. However, this study focuses on Edmodo classroom groups designed by researchers or teachers, which are private spaces with limited membership [6]. With a large membership base and opportunities for member-driven, bottom-up learning, Edmodo course communities are ripe for exploration. By understanding how participation in these online spaces shapes teaching and learning, researchers and educators can determine when and how to use these spaces for learning and provide better support for teachers as they engage in these online spaces [32]. Additionally, by taking a closer look at Edmodo course communities, administrators can determine if these online spaces complement current teacher professional development opportunities in their school or district [33]. Based on this need, this study was designed to examine teachers' perceptions of how engagement in the Edmodo physics course community affects their learning and practice.

Several studies on using Edmodo in education are included in the literature. In general, Edmodo apps are used by students studying at different levels of education. Edmodo is used to facilitate e-learning activities, and it was found that it supports collaboration and enables learning anywhere and anytime [34]. E-learning platforms such as Blackboard, Edmodo, Coursera, and Modular Object-Oriented Dynamic Learning Environments (Moodle) are believed to facilitate interaction with online students. In addition, these platforms are supported by Artificial intelligence (AI) systems such as intelligent tutor chatbots, natural language processing (NLP) algorithms, automatic grading of coursework, and predictive analytics to enhance the learning experience, provide timely support, and ultimately improve the overall effectiveness of online education in universities [35]. The use of AI in supporting the student learning experience is a growing area of interest in higher education [36]. AI is a technology where computers, robots, or bots engage in tasks that humans mostly perform. AI-driven e-learning platforms enable learners to obtain quality education at any time and from any location, improving the efficiency and effectiveness of the learning process [37]. Using Edmodo in the classroom is one of the many ways to integrate technology into teaching and learning. Edmodo allows teachers to design and develop interactive classroom activities online and integrate digital learning experiences that utilize technology to interact with students. Edmodo is a platform that uses Facebook and Twitter but in a controlled classroom environment. Using this platform in the classroom is advantageous as the skills needed to navigate the platform are already in the hands of the students [38].

Edmodo application in physics learning is very good as a learning support tool. This is evidenced by the use of Edmodo for chemical engineering students in Bahrain who are taking Thermodynamics. Almost half of the students were female, seemed comfortable with the online application, and were familiar with social media in different ways. Students' attitudes towards Edmodo were found to be positive, which means it can be used as a learning tool outside of the classroom. The impact on the students was evident, and more positive feedback and improvements could be achieved if Edmodo was used throughout the session [39]. Edmodo for students in Peru is used in learning that is very much in line with Generation Z. This generation was born amid social networks. Therefore, all economic, social, administrative, and even educational aspects related to them will be of concern. In particular, the Edmodo platform, which has the characteristics observed in this study, has excellent acceptance by this generation [40]. Digitally literate students have the potential to extend learning and conversation beyond the classroom. Thus, the researchers provided training on the Edmodo platform to help students in the experimental group learn from the online course content and participate in educational activities such as discussions and assignments [41]. Therefore, the importance of this study is related to the design and evaluation of the proposed educational program using the Edmodo platform. Therefore, this study aims to analyze the effect of the Edmodo application in improving students' cognitive abilities in physics on the topic of work and energy.

METHOD

This research uses descriptive research to describe the situation/symptom or phenomenon designed to obtain current information. In this case, the improvement of students' cognitive abilities can be seen by using the Edmodo application. The research design used is one group pretest-posttest design. The sample in this study was class 10 in the Science department, with a total of 27 students using a random sampling technique. Data was collected using a test of students' physics cognitive abilities. The data collection technique used was a test with an instrument consisting of 10 questions that experts had validated. Cognitive learning achievement data was obtained by answering essay questions that contained 10 items C2-C6. These questions assess students' understanding and ability to represent the concepts of work and energy. The interpretation scale of students' cognitive ability criteria can be seen in Table 1.

Table 1. Interpretation scale of learning outcomes criteria [42]

Interval	Criteria
0-30	Very less
31-60	Pretty good
61-80	Good
81-100	Very Good

In general, this study began with the provision of a pretest before the learning process activities began which were carried out on the Edmodo quiz feature. The pretest activity was given one week before the learning was carried out. The learning process in the classroom for the material of effort and energy was carried out 4 times. This learning activity only used one treatment class, where the teacher displayed a phenomenon that could be accessed on Edmodo, namely sharing a video link, in addition, in class learning the teacher gave a demonstration, the class discussed to create questions, in small groups students conducted experiments to answer questions and clarify answers, students presented the results, validated the model with the teacher, applied the model to new situations, and ended with a quiz and understanding test related to the material and phenomena presented at the beginning of the learning process. At the end of the learning process meeting, students were given a posttest to measure student competence after the application carried out with Edmodo. The research instrument for understanding the concept is the result of adaptation of several standard tests such as the energy and momentum concept survey (EMCS) [43] and mechanics baseline tests (MBT) [44] and several researchers developed it to complete it. Construct validation was carried out by physicists with master's degrees in physics and physics education to confirm and provide input on the competencies to be measured.

At each cognitive level, there are several indicators that students must master. When each cognitive level increases, the level of difficulty and complexity of the problem also increases so that students' complex thinking skills are needed. Therefore, the teacher can know the limits of students' abilities. Data from the pretest-posttest results were analyzed descriptively using percentages and averages (mean). This quantitative research processes data in the form of numbers to answer the problem formulation. Descriptive statistics describe or provide an overview of the object under study as it is without analyzing and drawing conclusions that apply generally. The descriptive analysis used in this study consists of the average value of student physics learning outcomes, the highest empirical value, the lowest empirical value, variance, and standard deviation [45].

RESULTS AND DISCUSSIONS

Summary of data analysis Figure 1 shows a significant difference between the pre-and posttest performance scores of physics cognitive ability students who learn using the Edmodo application. In other words, students who studied with Edmodo used by their teachers performed better. This result is consistent with the findings who stated that computer-based learning, such as animation and textual strategies, can improve Physics learning outcomes in senior secondary schools regardless of students' gender [6]. This also corroborates the findings who found that animation and textual information in a computer-based environment can help improve student learning outcomes in physics [46].

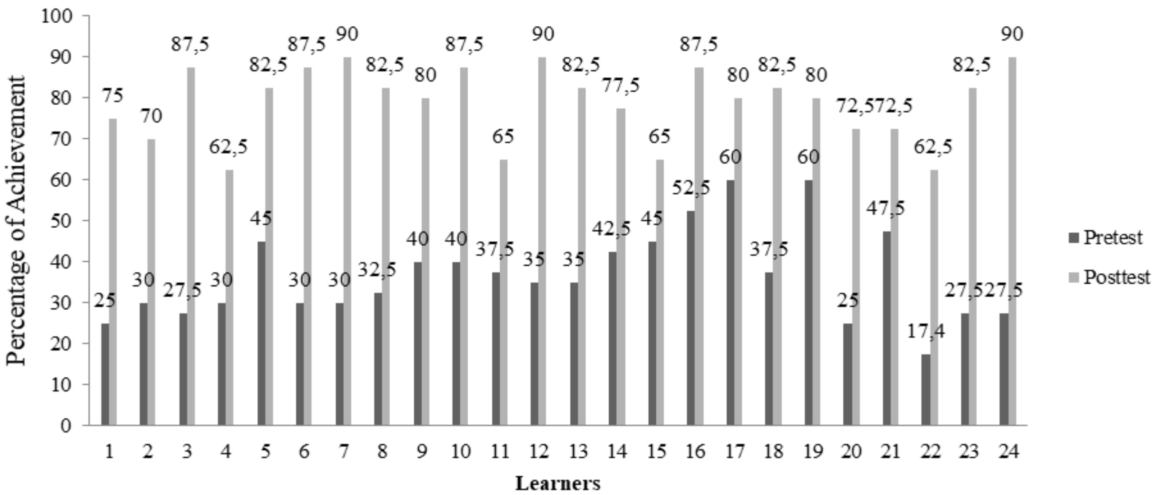

Fig 1. *Students' pretest and posttest results for the cognitive ability test*

The results show that students exposed to the animation strategy performed best, followed by the textual strategy, while the controlled students performed the lowest, suggesting that multimedia learning is a way to reduce students' low level of cognitive achievement in physics. The second hypothesis was proposed to determine the effect of strategy on students' attitudes towards Physics. In addition, the results who argues that low student interest and lack of motivation, among other factors, lead to low physics learning, resulting in poor performance in physics subjects [47]. In other words, the results of this study indicate that learning outcomes can be improved by integrating learning packages such as computer-based packages, animated information, and textual information in physics learning in senior high schools. Physics learning in the classroom, which is only theory-based, affects learning outcomes negatively. Thus, the physics teaching and learning process should be structured to maintain student learning outcomes that can captivate and stimulate student interest for better performance. Teachers should use learning packages such as cartoons or computer-based materials to make the physics teaching and learning process more engaging. Teachers should be creative and

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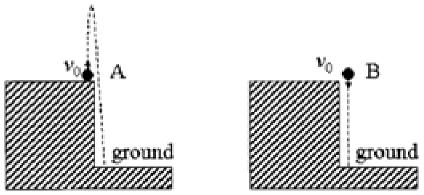
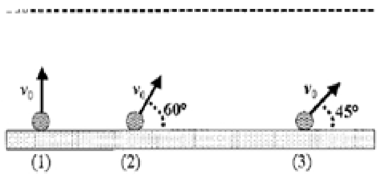
technologically inclined. Such strategies will improve students' attitudes toward physics learning for better performance [48].

1 Two identical stones, A and B, are shot from a cliff from the same height and with identical initial speeds v_0. Stone A is shot vertically up, and stone B is shot vertically down (see diagram). Which one of the following statements best describes which stone has a larger speed right before it hits the ground?



(a) Both stones have the same speed.
(b) A, because it travels a longer path.
(c) A, because it takes a longer time.
(d) A, because it travels a longer path and takes a longer time.
(e) B, because no work is done against the gravitational force.

2 Three balls are launched from the same horizontal level with identical speeds v_0 as shown below. Ball (1) is launched vertically upward, ball (2) at an angle of 60°, and ball (3) at an angle of 45°. In order of decreasing speed (fastest first), rank the speed each one attains when it reaches the level of the dashed horizontal line. All three balls have sufficient speed to reach the dashed line.

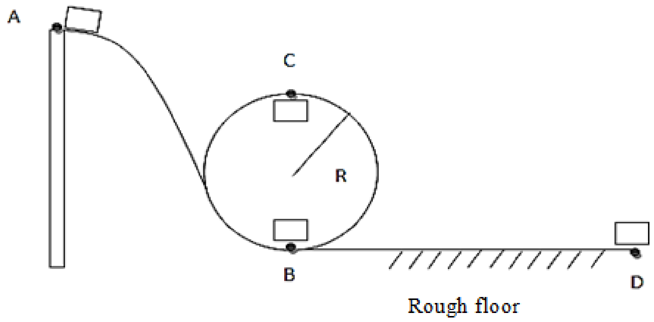


(a) (1), (2), (3)
(b) (1), (3), (2)
(c) (3), (2), (1)
(d) They all have the same speed.
(e) Not enough information, their speeds will depend on their masses.

Fig 2. *Work and Energy Test Questions for Number 1 and 2* [43]

Question 3

A block starts from point A at the top of a frictionless inclined plane at height *h*, as shown in Figure 2. At the base of the inclined plane, the block passes through a circular path and then moves across a rough horizontal surface. What minimum height is required for the block to complete one full rotation?



A. 3/2 R
B. 2R
C. 5/2 R
D. ½ R
E. 3R

Fig 3. *Students' incorrect conception on number 3* [49]

Question 3 shows that the law of conservation of mechanical energy applies. From the point A → C, the equation is

$$E_{pA} + E_{kA} = E_{pC} + E_{kC} \tag{1}$$

Equation (1) states that an object with velocity and the force exerted is in the same direction, so if the force causes acceleration on an object with mass, the object will move faster. Furthermore, this can be explained by using the law of conservation of mechanical energy, which can be obtained from equation (2).

$$\boldsymbol{m\,g\,h\;=m\,g\,(2R)+\frac{1}{2}\,m\,v_c{}^2} \tag{2}$$

Regardless of the mass, the velocity at point C is obtained in equation (3)

$$\boldsymbol{v_c=\sqrt{2\,g\,(h-2R}} \tag{3}$$

To get the minimum height of an object on a full circle, we can use equation (4)

$$\boldsymbol{2\,g\,(h-2R)=v_c{}^2} \tag{4}$$

Then, it is obtained from equation (5) that the maximum height of the object when crossing a full circle is $\boldsymbol{h_{min}} = {}^{\boldsymbol{5}}\!/_{\boldsymbol{2}}\ \boldsymbol{R}$. From the interview results, there are still many students who assume that the object will cross the path of a circle with a minimum height of 2R. This is why things still need to be clarified when learning physics concepts. Educators usually use various external representations to teach highly generalizable concepts and principles of physics and mathematics. Such misunderstandings can occur due to various factors, one of which is intuition [50].

Table 2. Percentage of correct students' cognitive ability in physics

Question Number	**Conceptual Area**	**Students correct conception**
1	Work Exerted by a Fixed Force	75,5%
2	Work Exerted by a Changing Force	60,6%
3	Mechanical Energy Conservation Theorem	78,5%
4	Conservation of Mechanical Energy	80,7%
5	Isolated System-Conservation of Mechanical Energy	67,6%
6	Graph of Kinetic Energy and Velocity Relationship	85,6%
7	Work with Negative Values	65,6%
8	Non-isolated System-Energy Conservation	76,5%
9	Conservative force of a system	62,5%
10	The difference in kinetic energy of objects with different masses	80,5%

Data Table 2 shows that students have a relatively good average score of students' cognitive abilities. Students' cognitive abilities are essential for solving complex and unpredictable problem situations in the professional field. Given the increasing level of uncertainty and variability of the external environment, such abilities are essential for flexible adaptation and creative performance of work tasks. Working with large amounts of data and information also requires the development of cognitive abilities [38]. With the invention of Web-based classroom instruments, many new facilities on how to apply online technologies, such as social networks for successful learning, have led researchers to explore how best to utilize these instruments. Much research is being done on social networks such as Facebook and Twitter as language teaching and learning tools. Another social network that is coming soon specifically for teaching and learning is Edmodo. Being familiar with the popularity of Social Networking Sites (SNS) among learners, teachers are starting to utilize their instruction with SNS, especially to develop learners' autonomy, attitude, and motivation to learn. Several studies on using SNS with teaching show that SNS can improve learners' general learning performance and strengthen their learning motivation. SNSs are platforms that facilitate ways to interact with others, share materials and ideas, and collect feedback seamlessly. This connection element is the main difference between social media and traditional media. Over the past few decades, many online programs have been designed to help language learners learn languages more effectively [47]. As stated above, one of the latest online tools available to teachers is Edmodo, which is the focus of this study. Edmodo is an online social networking website and smartphone application designed for teachers and students. Edmodo allows teachers to communicate with students, share materials, and monitor student progress. This study seeks to examine the effect of the Edmodo social learning network on Iranian learners' writing skills [51]. The results of the study in India explain that to facilitate student-centered learning and to improve student learning outcomes, web-based technology is important to present practical problems and provide related cases to students. In a web-based learning environment, students' prior knowledge influences the process of understanding concepts. Prior knowledge and pedagogical strategies in the learning environment mediate students' ability to develop cognitive skills. Thus, students are required to develop homogeneous background knowledge about the topics being studied [52]. In addition, students at Taibah University in Saudi Arabia also feel helped by using the Edmodo application for mobile learning environments because it has many benefits in supporting the learning process, such as facilitating and increasing the effectiveness of learning communication, allowing them to learn at the right time and improving their cognitive learning outcomes [53].

First introduced in the US in 2008 as a social network for teachers/learners in various educational contexts, Edmodo has become one of the most well-known learning platforms, with over 100 million registered users in more than 195 countries worldwide. This growing popularity is due to Edmodo's user-friendly interface, free services, and diversity of educational functions. Also referred to as a micro-blogging service [54], a social networking website or forum [55], an internet-based learning management system [56], text-based asynchronous social media [57], and Facebook or cloud-based interactive learning platforms for higher education [6]. Edmodo presents a cloud-based social learning platform that offers smartphone applications and includes features of social networking sites. Edmodo can also positively impact prospective teachers' pedagogical development by helping them make connections between theoretical and practical science teaching activities and allowing them to share their views. This study aimed to determine the role of Edmodo in educating prospective primary school teachers about science teaching and to ascertain prospective teachers' opinions about using Edmodo in teacher education. The findings suggest that Edmodo is a valuable and cost-effective tool for learning [51].

In 1949, Benjamin S. Bloom proposed the idea of a division or cognitive taxonomy to facilitate the process of compiling question banks to create shared learning objectives [58]. Bloom and his team published the taxonomy in 1956. Forty-five years later, David R. Krathwohl, one of Bloom's team members, proposed Bloom's Revised Taxonomy. To formulate the taxonomy, Krathwohl worked with seven experts in physiology and education. The changes from the original to the revised framework are illustrated in Table 3.

Table 3. Bloom's taxonomy and revised Bloom's Taxonomy

Bloom's Taxonomy (1965)	Revised Bloom's Taxonomy (2001)
Knowledge	Remember (C1)
Comprehension	Understand (C2)
Application	Apply (C3)
Analysis	Analyze (C4)
Synthesis	Evaluate (C5)
Evaluation	Create (C6)

Six cognitive taxonomies of the Revised Bloom's Taxonomy: remember, understand, apply, analyze, evaluate, and create. Each category consists of two or more cognitive processes. Evaluation of cognitive ability is one of the most critical aspects of the learning process. Cognitive abilities are based on brain function and are required for all activities, from the easiest to the most challenging. These abilities are mainly involved in learning, remembering, problem-solving activities, and paying attention [59]. Cognitive capacity is considered an accelerator for goal-oriented learning, positively influencing academic achievement [6]. Since teacher instruction and feedback are the primary sources of information for students in their acquisition of cognitive skills and practices, teachers are believed to be implicitly aware of their students' cognitive skills. Therefore, it is imperative to avoid unfavorable information, while rapid evaluation and action are anticipated to stimulate the development of cognitive capacity. To realize this imperative, instructors need to closely monitor the development of their students' cognitive abilities, which may vary from student to student. To better understand the specific needs of students, researchers have begun to focus on how students learn in online environments, with a particular emphasis on student engagement in online learning [60], student recall [61], and their emotional and behavioral patterns throughout their academic careers [62]. A critical goal in distance learning is to maintain students' attention, which is the initial stage in the learning process. Although the human brain is very effective at processing information, it has a limited capacity, so it cannot simultaneously respond to all external inputs and memories [63].

CONCLUSION AND SUGGESTION

Based on the findings, the Edmodo application can improve students' cognitive abilities in physics. By increasing students' physics cognitive abilities in learning, student learning outcomes that were previously low increased significantly. The learning process in every school that supports and facilitates the existence of technological devices can utilize Edmodo learning media assisted by meeting room media in the current situation that requires schools to conduct face-to-face learning. Some suggestions can be made: 1) This study proves that the use of the Edmodo Application has succeeded in improving students' cognitive abilities on the material of work and energy. Schools should use the Edmodo Application to support the learning process; 2) Edmodo media can be used as an alternative to learning that can improve students' cognitive abilities. By applying the Edmodo Application, students become excited about the learning process, do assignments, and learn outside the classroom. Besides, it makes it easier for teachers to deliver material that can be delivered anytime and anywhere; 3) Further research is needed as a development of this research on other materials, learning models, and different research samples; 4) It is hoped that students can be more active in the learning process in providing suggestions for expressing opinions when active on Edmodo.

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