Bukti Korespondensi

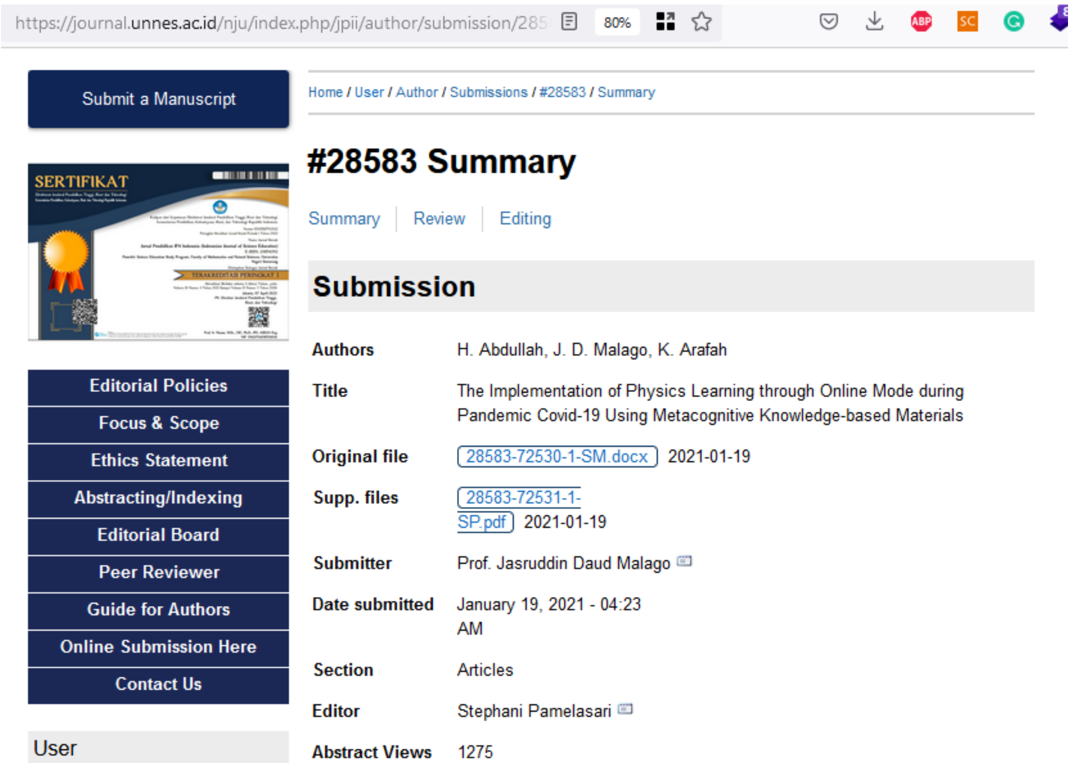
Implementation of Metacognitive Knowledge-Based Physics Teaching Materials through Online Learning during the Covid-19 Pandemic

Helmi Abdullah, Jasruddin Daud Malago, Kaharuddin Arafah

Jurnal Pendidikan IPA Indonesia
Vol. 10, No. 2, 2021
https://journal.unnes.ac.id/nju/index.php/jpii/author/submission/28583

Tanggal	Aktivitas
2021-01-19	Submit manuskrip pertama kali di JPII via OJS
2021-04-15	Keputusan Review: Revisions Required
2021-04-25	Submit hasil revisi melalui OJS
2021-05-24	Keputusan Review: Accepted with revision
2021-06-30	Publish tanpa PDF
2021-07-05	Submit proofreading
2021-07-30	PDF publish

Submit manuskrip pertama kali di JPII via OJS


https://journal.unnes.ac.id/nju/index.php/jpii/author/submission/285 80%

Submit a Manuscript

SERTIFIKAT

Editorial Policies
Focus & Scope
Ethics Statement
Abstracting/Indexing
Editorial Board
Peer Reviewer
Guide for Authors
Online Submission Here
Contact Us

User

Home / User / Author / Submissions / #28583 / Summary

#28583 Summary

Summary | Review | Editing

Submission

Authors	H. Abdullah, J. D. Malago, K. Arafah
Title	The Implementation of Physics Learning through Online Mode during Pandemic Covid-19 Using Metacognitive Knowledge-based Materials
Original file	28583-72530-1-SM.docx 2021-01-19
Supp. files	28583-72531-1-SP.pdf 2021-01-19
Submitter	Prof. Jasruddin Daud Malago
Date submitted	January 19, 2021 - 04:23 AM
Section	Articles
Editor	Stephani Pamelasari
Abstract Views	1275

Keputusan Review: Revisions Required

Commented [U1]: Please use JPII template.

Implementation of Metacognitive Knowledge-Based Physics Teaching Materials Through Online Learning During the Pandemic Covid-19

Helmi Abdullah[1], Jasruddin Daud Malago[1], Kaharuddin Arafah[1]
Physics Education Department, Universitas Negeri Makassar, Indonesia
E-mail: jasruddin@unm.ac.id

Abstract. This study aims to analyze the effect of metacognitive knowledge-based physics teaching materials (BAFPM) on the ability to analyze metacognitive knowledge. This teaching material was applied through online learning during the Pandemi Covid-19. The research design used *a post-test only control group.* Two groups were used: the experimental group totaling 120 students and the control group totaling 124 students. Students aged 15 to 17 years, who came from public senior high schools. The results showed that the mean score of metacognitive knowledge analysis skills (KAPM) in the experimental group was 13.24 (20) and the control group was 8.83 (20). The hypothesis testing results indicate a difference in the average KAPM score obtained by the two groups at the confidence level α = 0.05. The results show that BAFPM has an influence on KAPM compared to conventional-based teaching materials (BAK).

Keywords: Analytical skills, KAPM, Teaching materials, Metacognitive knowledge

1. Introduction

Commented [U2]: Do not use numbering.

Commented [U3]: INTRODUCTION should:
• contain urgency (importance) to research
• contain a carrying capacity in the form of supporting data and facts
• contain a preliminary study as a basis for the importance of the research conducted
• contain a GAP ANALYSIS Departing from the preliminary study, analysis of published articles formulated in the Gap analysis
GAP ANALYSIS refers to articles published in various internationally reputable journals to emphasize the novelty of research.
• clear limitation of research objectives

Commented [U4]: Use et al for more than 2 authors. Please check the others.

Physics is a basic science that deals with nature's behavior and structure. Physics is taught to find order through observing nature (Giancoli (2014). Lederman (2006) states that physics is not just a collection of knowledge, but more than that, science is a way of thinking, a form of investigating, and a body of knowledge. Based on this view, physics is nothing but basic knowledge that studies the behavior of objects, technological products, and natural phenomena that contain the values of life. Kim, Cheong, & Song (2018) suggest that physical equations are needed to study natural behavior. Through equations, the characteristics of natural behavior and their interactions with other natural conditions can be seen. For example, the phenomenon of rain is a natural behavior that does not stand alone. Still, precipitation occurs because of the process of evaporation, sublimation, and melting in addition to other methods.

There are two essential aspects of learning, namely teaching and teaching outcomes. A good education will produce good learning results too. Teaching is a respectable profession where a teacher must make changes in values and knowledge that can be useful for students in facing their daily lives (Bropy, 2010). Kerr & Lloyd (2008) specifically stated that teaching would be more meaningful if concepts, principles, and theories can be turned into practical experiences so that students can understand real situations. Based on these two views, teaching is an activity carried out by the teacher to help students achieve goals that are beneficial to them. Therefore, teaching a fun strategy is needed so that the knowledge and values taught can be well understood by students (Rebecca, 2003).

Efforts to achieve teaching goals depend heavily on the use of teaching strategies. A good teaching strategy is a modified strategy. Therefore, nowadays, a lot of research on strategy implementation and testing has been carried out by recent teachers (Jonassen, 1991; Napoli, 2004; Langley & Eylon, 2006). This shows that the importance of teaching strategies is known and understood by teachers. However, many of the new strategy developed by teachers do not use the theoretical basis of student learning and development. Many teachers fail to implement a plan even though the process has been very successful in other schools (Ramsden, 1998). This condition often occurs in teachers in Indonesia. Every learning model applied by the teacher based on the Ministry of National Education policies cannot be adequately implemented because it is not suitable for geographical conditions, environment, culture, and student characteristics. Maybe this learning model is ideal for individual schools but not for other schools. This problem has been going on since Indonesia's independence. Therefore, to overcome this problem, the research team has developed "multi-conceptual based physics teaching materials" as a component of implementing physics teaching strategies during the pandemic Covid-19.

Why must the teaching materials be developed? The reason is that the teaching strategy is closely related to the teaching materials developed by the teacher. The content of physics teaching materials generally consists of facts, concepts, laws, principles, formulations, theories, postulates, and rules. The more complex the material content, the more complex teaching strategies are required. Teaching materials are learning tools that contain aspects of knowledge to achieve specific learning objectives, as set out in the lesson plan. (Lewis, 2009).

Teaching materials are closely related to the dimensions of knowledge. Anderson and Krathwohl (2010) divided the dimensions of knowledge into four dimensions: factual, conceptual, procedural, and metacognitive knowledge. Factual knowledge is knowledge about facts or reality. Several facts which have the same characteristics is called conceptual knowledge. Procedural knowledge is the relationship between concepts. Meanwhile, metacognitive knowledge is related to the integration of conceptual and procedural knowledge in solving problems. Among the four dimensions of knowledge, the dimension of metacognitive knowledge is the knowledge that must be developed in physics teaching materials. This is indicated by Lin (2001) that metacognition is the ability to understand and monitor ways of thinking and its implications for its activities. Dawson (2008), Coskun (2010) and Shanon (2008) define metacognition as thinking about thinking.

Veenman, Wolters, and Afflerbach (2006) and Wernke, Wagener, Anschuetz, & Moschner (2011) state that metacognition is "*high-order cognition about cognition*." Duque, Baird, and Posner (2000) define metacognition as a process of thinking about cognitive abilities, cognitive strategies, about cognitive tasks. This explanation implies that metacognition is more oriented towards higher-order thinking processes, and one of the components of higher-order thinking is critical thinking skills. This is in line with Jacobs and Paris (cited in Michalsky, Mevarech, & Haibi, 2009), which states that metacognition is "self-awareness of one's knowledge, about one's task, about thinking, and self-control of cognitive processes." Jacob & Paris's statement implicitly implies that people who have good metacognition abilities will automatically think at high levels because the ability to control cognitive activity will make it easier to perform higher-order thinking skills (Ozsoya & Ataman, 2009; Pennequin et al., 2010). This is why, in the 21st century, where information technology is rapidly developing, higher-order thinking skills are needed to answer very complex problems.

Meanwhile, according to the view of Santrock (2007) is strategic knowledge about how and when to use specific procedures to solve problems. Arends stated the same thing (2010), that metacognitive knowledge is knowledge about learners' cognition and learning about when to use conceptual or procedural knowledge to solve problems. From these two definitions, it can be argued that the leading indicator of metacognitive knowledge is problem-based knowledge. This is stated by Torkamani (2010) that metacognitive knowledge is the knowledge that is used to solve problems (problem-solving). Even more than that, according to Lee & Baylor (2006), metacognitive knowledge is the knowledge that is used to organize and organize thought processes to solve problems. Thus it can be concluded that the characteristics of metacognitive knowledge are problem-solving based.

Research Question

Commented [U5]: Avoid in using sub-heading. Please check for others.

Based on the explanation above, it can be concluded that to optimize students' thinking skills in the 21st century; it is very important to teach metacognitive knowledge. To make this happen, this dimension of knowledge must be injected into teaching materials. The research team has designed and developed physics teaching materials based on metacognitive knowledge during the Covid-19 pandemic since the beginning of 2000. The development process is through development research procedures and has been revised three times based on learning experts, material experts, language experts, and experts. Graphics and followed up through focus group discussion activities using the zoom application. At the end of September 2020 it was declared feasible to be implemented through research activities. Implementation in public senior high school students aged around 15 to 17 years. Therefore, the questions in this study are: (1) How big is the KAPM average score obtained by the experimental group students? (2) How big do the control group students obtain the KAPM average score? (3) Is there a difference in the average KAPM score between students in the experimental group and students in the control group?

Both groups were taught in online learning. What distinguishes is the use of teaching materials. The experimental group used physics teaching materials based on metacognitive knowledge, and the control group was taught using cognitive-based teaching materials. As a summary of the differences between the two teaching materials, the following concept maps are presented as follows

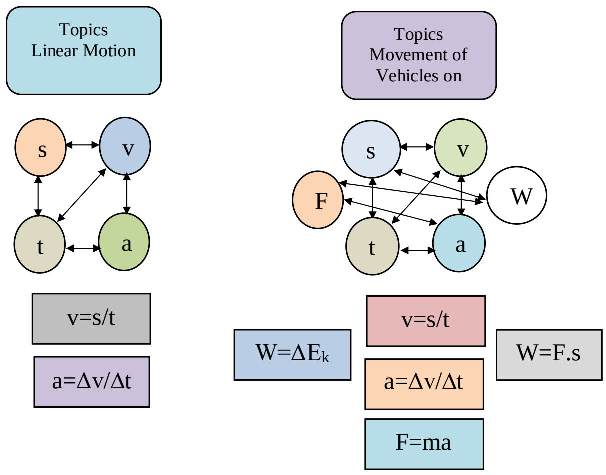


Figure 1. Differences in cognitive and metacognitive based teaching materials

Based on cognitive knowledge, physics teaching materials are teaching materials developed by the teacher based on the material's order in the physics textbook. In Makassar, high school physics teachers in developing physics teaching materials always refer to the book "Physics-Principles With Applications" by Giancoli (2014). The teacher's physics teaching materials are by order of the material in Giancoli's book. For example, for the subject: One Dimensional Kinematics, the sub-subjects order is reference frame & displacement-Average Velocity-Instantaneous Velocity-Acceleration-Motion at Constan Acceleration-Solving Problems. In a review from the learning aspect, that the arrangement of physics teaching materials like this has weaknesses, namely: (1) It is theoretical and conceptual, (2) Examples of questions developed are limited to the use of formulations (such as s=vt dan a=Δv/Δt), (3) The variables taught are lacking. The development of physics teaching materials like this is called the development of cognitive-based teaching materials. Because this teaching material only emphasizes developing the ability to remember, understand, and apply. At the same time, the aspects of analyzing, assessing, creating are deficient levels.

The 21st-century learning has changed learning from the cognitive aspect to the metacognitive aspect. Therefore, a paradigm shift is needed to prepare physics teaching materials from cognition-based to metacognition based. Why? Because only metacognitive knowledge can develop students' thinking abilities, such as the ability to analyze, assess, think critically, and think creatively. This is consistent with Santrock (2007) view that metacognitive knowledge is strategic knowledge about how and when to use specific procedures to solve problems. The same thing was stated by Arends (2010), that metacognitive knowledge is knowledge about learners' cognition and knowledge about when to use conceptual or procedural knowledge to solve problems. There is a similarity between Arend & Santrock's view, namely, solving problems. Meanwhile, problem-solving requires the ability to think metacognition (or higher-order thinking). Therefore the research team has developed physics teaching materials based on metacognitive knowledge. How is the structure of the teaching materials based on metacognitive knowledge?

The scheme for developing physics teaching materials based on metacognitive knowledge is shown in Figure 1 (b) above. The development mechanism is not based on the order of material in the texts-book, but is based on events around the students' environment. For example, the topic for the discussion of vehicle movement on the highway is chosen. Of course, many things can be expressed by the motion of vehicles on toll roads, such as: the motion of a car that is accelerated slowly, the motion of a car that is driving constantly, the motion of a car that is ahead of other cars. These incidents were the topic of discussion. In terms of variables to be developed in teaching materials, there are two variables, namely the main variable which includes speed (v), acceleration (a), distance traveled (s), and travel time (t) (such as s=vt and a=Δv/Δt) and supporting variables such as: force (F), work (W), kinetic energy (E). The combination of the primary and supporting variables will enrich the cohesiveness between variables. So that in studying straight motion or vehicle motion, the kinematics aspect (primary variable) is not taught as well as the dynamics aspect (complementary variables).

The advantages of physics teaching materials based on metacognitive knowledge are: (1) students can understand the relationships between kinematic variables and dynamic variables, (2) students have a comprehensive understanding of motion and force, (3) students have no difficulty learning the dynamics of motion because they have introduced earlier in the topic of kinematics and (4) allows students to develop metacognitive thinking skills. Here is an example of questions from cognitive knowledge-based teaching materials with metacognitive knowledge-based teaching materials such as Table 1 below.

Table 1. Examples of learning materials based on cognitive and metacognitive knowledge

Example Problems on Teaching Materials	
Cognitive Knowledge-based Teaching Materials	Metacognitive Knowledge-Based Teaching Materials
The car is driving at a constant 20m / s highway. At 200m in front of the car, a truck overturned. Specify: a. Minimum slowdown of the car so as not to hit the truck. b. b. car average speed	The car is driving at a constant 20 m/s highway. At 200m in front of the car, a truck overturned. Specify: a. Minimum slowdown of the car so as not to hit the truck. b. car average speed c. If the mass of the car is 1000kg, determine the amount of braking force. d. Effort by the braking force e. The maximum kinetic energy of the car
Note: This example problem only introduces the formula: S=vt and $v^2=v_o^2 \pm 2as$	Note: This example problem presents the procedure: S=vt, $v^2=v_o^2 \pm 2as$, F=ma, W=FS, and E=½mv^2

Based on the explanation of these two types of teaching materials, it can be ascertained that physics teaching materials based on metacognitive knowledge will contribute to analyzing metacognitive knowledge compared to physics teaching materials based on cognitive knowledge. Physics teaching materials based on cognitive knowledge can also contribute to students' metacognitive knowledge analysis skills; it's just that the quality is still low. Therefore, to determine that physics teaching materials contain metacognitive knowledge, a measuring tool is needed to measure the teaching material after being applied to students. The measuring instrument is called "*Metacognitive Knowledge Analysis Ability (KAPM)*". This measuring instrument is structured following metacognitive knowledge principles with the following characteristics: (1) Problem-based question statements, (2) containing more than procedural knowledge. The more procedural knowledge in the questions, the higher the level of metacognitive knowledge.

2. Research Methods

Commented [U6]: METHODS should
- contain detailed research stages
- Each stage is explained and analyzed by what method
- Data analysis must be with clear references
- The research instruments used were elaborated to the data analysis technique
- It is hoped that there will be a modification in the stages of research from sources referred by the researcher

Types and Research Samples

To answer the problem formulation above, the method used in this study is a quasi-experimental research design with a "post-test only control group." This study involved two groups of students, namely, the experimental group using BAF-PM and the control group using conventional teaching materials (BAK). Both groups used online learning. As for the experimental group, students from public senior high school (SMAN) 2 Makassar and the control group were SMAN 9 Makassar students in Indonesia. The age of the students sampled was around 15 to 17 years old. The total number of samples in this study is shown in Table1.

Table 2. Number of students in each experimental and control group

Experiment Group (SMAN 2 Makassar)		**Control Group (SMAN 9 Makassar)**	
Class Name	The number of students	Class Name	The number of students
Class XI MIA.1	31	Kelas XI MIA.1	32
Class XI MIA.2	30	Kelas XI MIA.2	31
ClassXI MIA.3	29	Kelas XI MIA.3	30

Class XI MIA.4	30	Kelas XI MIA.4	31
Total	120	Total	124

Meanwhile, the number of physics teachers used as teachers in online learning is four teachers from the experimental group and two teachers from the control group. The four teachers have more than ten years of teaching experience, so they are considered expert teachers.

Research procedure

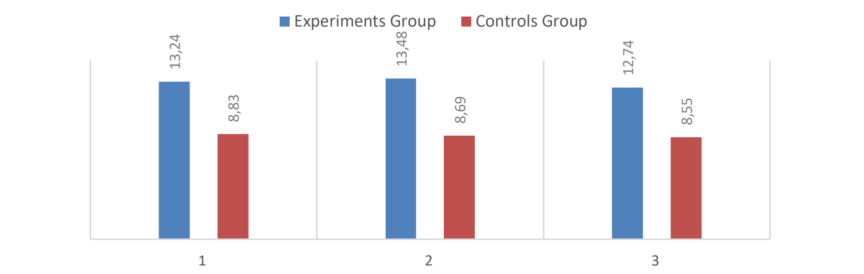
Prior to implementing online learning, the research team conducted intensive training on teaching materials, made power points, used zoom (online internet), and used google forms as a learning evaluation tool. Training activities are carried out for eight days of working time. After implementing the training, teachers convey information to students through the Whatshap Group application to determine online teaching schedules. Each teacher faces two classes, which is done in a scheduled manner according to the provisions of the school schedule. The time required for each stage of online learning is 90 minutes per week and lasts three weeks. In the fourth week, the KAPM test was conducted simultaneously using google form.

3. Results

As long as the teaching took place, nothing happened that would spoil this research plan. Everything went according to plan, right up to the data collection stage. The collected data is in the form of 244 answer sheets. The answer sheet is checked and given a score, then analyzed descriptively and inferentially. The processing results to describe a description of the two groups' analytical abilities is shown in the following graph.

Commented [U7]: RESULTS AND DISCUSSION
- Tables or graphs (one selected) must represent different results
- The results of data analysis must be strong in answering the analysis gap
- Display of results other than those narrated in table-graph-image-modeling
- The research novelty has not been clear enough
- It is recommended not to repeat the references in the introduction, using previous research findings.
- References used should be taken from reputable journals.

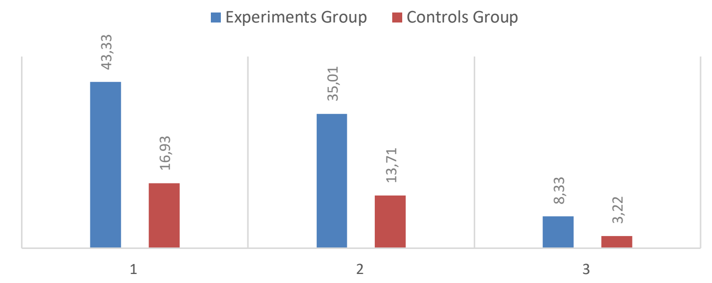
It is necessary to explain the specifications of the findings in this study that show



Note:
1= All Gender, 2= Females, 3= Males

Figure 2. Mean score of the metacognitive knowledge analysis test.

It can be seen in the bar chart in Figure-2 that there is a difference in the mean score of the metacognitive knowledge analysis test between the experimental group and the control group. Overall regardless of gender, the mean scores of the experimental group were x1 = 13.24 (20) and Sd1 = 4.25, while the control group was x2 = 8.83 (20) and Sd2 = 4.22. Meanwhile, when viewed from gender differences, it turns out that the experimental group was still superior to the control group. The female students' mean score in the experiment group was 13.48 (20), and the control group was 8.69 (20). Likewise, for male students, the experimental group obtained 12.74 (20), and the control group obtained 8.55 (20). So the overall description of the experimental group has better learning outcomes than the control group.



Note
1= All Gender,   2= Females,   3= Males

Figure 3. Percentage of students who scored ≥ 14 (maximum score of 20)

While the results shown in the bar chart in Figure-2 show an overview of the results of the metacognitive knowledge analysis test. The experimental group has a difference in the average score with the control group, where the experimental group is superior to the control group. Likewise, the percentage of students who obtained scores above or equal to 14, the experimental group was still superior to the control group. From these data, it can be concluded that a multi-conceptual based physics teaching strategy is superior to a mono-conceptual based physics learning strategy. However, hypothesis testing is still needed to strengthen this conclusion further.

As for testing the hypothesis of the difference in metacognitive knowledge analysis test scores between the experimental and control group, the t-test was used. The results of testing data processing are as shown in the following table.

Table 3. Hypothesis testing data

No	Variable	Group	
		Experiment	Control
1	Number of the sample (n)	120	124
2	Average Skor (X)	13.24	8.83
3	Standard Deviation (S)	4.25	4.22
4	Variants (S^2)	18.06	17.81
5	t_{table} for degrees of freedom (n_1+n_2-2) = 242 dan α=0.05	1.97	
6	t_{value}	8.50	

Based on the information on the hypothesis testing data, the results show that t = 8.50> t table = 1.97. This test reinforces the above description statement, that overall, a multi-conceptual based physics teaching strategy has an advantage over the ability to analyze metacognitive knowledge compared to a mono-conceptual based physics teaching approach.

4. Discussions

Commented [U8]: Results and Discussion is not separated.

Although there are limitations in this study, the difference in the average KAPM score of the student group using BAF-PM and the student group using BAK is an indication that the use of BAF-PM is relatively good in growing KAPM. This means that overall the two groups received the same treatment except for different physics teaching materials. Thus it can be stated that BAF-PM can relatively grow KAPM. Therefore, it is natural that learning experts believe that the preparation of teaching materials largely determines the success of a lesson through alignment between individual differences and learning objectives (Riding & Douglas 1999; Pitchers, 2002).

Teaching strategies are mostly used to apply learning theory in useful ways and achieve targeted learning outcomes (Miller & Veatch 2010). On the other hand, Marzano (2003) states that the primary component that affects student learning outcomes is the teaching strategy. However, the success of the system is largely determined by the development of teaching materials. That is why the teaching strategy and teaching materials are not separated. Both form a unity as the main component in learning.

Therefore, for the teaching strategy to be achieved optimally, the teaching materials developed must facilitate student learning (Romiszowski, 2008). The purpose of facilitating is to direct and guide students to be able to think at higher levels. In line with the suggestion put forward by Dhull & Verma (2020) that physics is a complex subject that requires the use of skills such as critical thinking, logical thinking, and problem-solving skills. To possess these skills, the teacher must do strategic planning based on the characteristics of physics lessons. One of the characteristics of knowledge that can foster higher-order thinking skills is metacognitive knowledge, as stated in the introduction. Based on the expert's view expressed above, the description of physics teaching materials based on metacognitive knowledge is stated in the knowledge tree diagram shown in Figure 4.

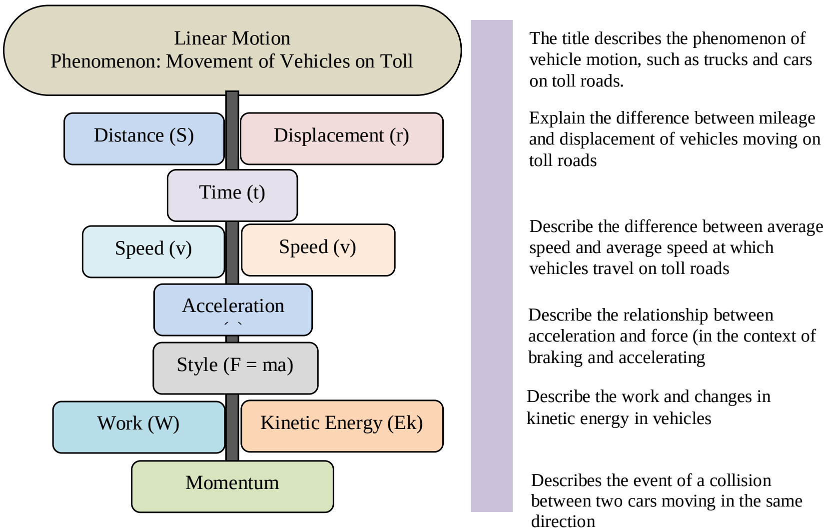


Figure 4. *Tree* diagram of material content as teaching plan ideas

The development of physics teaching materials must refer to concrete objects and everyday events because it will help students connect abstract concepts and the real world (Brown, Neil, & Glernberg, 2009). As seen in the knowledge tree diagram above, vehicles' movement on toll roads is an everyday occurrence full of concepts and procedures, and the relationship between ideas and techniques. This is the basic principle of metacognitive knowledge. The relationship between concepts and methods is discussed in an everyday event (Stoica, Moraru, & Miron, 2011). Thus the development of physics teaching materials based on metacognitive knowledge is a strategy that effectively supports the 21st-century learning paradigm.

5. Limitations and Implications

Commented [U9]: Please check for JPII guidelines.

There are two variables involved in this research: physics teaching materials based on metacognitive knowledge and KAPM. When online learning occurs, there are many reports of internet network disruptions experienced by students and teachers. Conditions sufficiently affect the results of the study. Also, the atmosphere of students studying at home is very much influenced by the needs of the student's home environment and the student's psychological factors. So the researchers suspect that the average KAPM score obtained by the experimental group is 13.24 and the control class is 8.83, not entirely due to the treatment is given. This is the limitation experienced by the research team while researching the Covid-19 pandemic.

Physics teaching materials based on metacognitive knowledge are a model of learning materials that are needed in the 21st century learning era that promotes critical, creative, communication and collaboration thinking. So that the results of the research will greatly help physics teachers how to develop physics teaching materials to support 21st century learning. Also, the implementation of online learning during the study has provided many skills to use internet technology, especially how to make teaching materials in application programs such as power points. How to use online learning applications, such as zooming, and how to make assessments via a google form.

6. Conclusions and Recommendation for Future

Commented [U10]: Pleae adjust with JPII guidelines.

Frelberg & Driscoll (1992) stated that teaching strategies can be used to achieve various learning objectives. Meanwhile, the teaching strategy is closely related to the development of teaching materials. Even the teaching material is a scenario of a teaching strategy. One of the failures of students being unable to solve problem-based or metacognitive knowledge-based problems is students' difficulty connecting concepts and procedures. This fact shows that the teaching materials used are more theoretical or traditional (Gilbert, Watts, & Osborne, 1982; Gunstone, 1987). Teaching materials are important tools in studying every subject in the school curriculum. They allow students to interact with words, symbols, and ideas in ways that develop their ability to read, listen, solve, see, think, speak, write, use media and technology (Bukoye, 2008).

Commented [U11]: Avoid using citations in Conclusion.

Based on the findings in this study and the views of learning experts, it can be concluded that teaching materials (including BAFPM) are the main components in learning that much determine the achievement of learning outcomes.

This research is exciting, namely, the implementation of physics learning during the Covid-19 period through online learning. So, it is as if the Covid outbreak can be overcome, then online education is only a memory for schools that have been holding classroom learning. This statement has some truth in it, but it should be noted that the development of education will lead to efficiency and effectiveness in the future. Especially now, the development of communication technology is very fast, so that one-day online learning will become companion learning for classroom learning. As Nacol (2006) reported, online learning through virtual schools is one of the most critical advances in efforts to rethink the effectiveness of education. The virtual school provides access to an online, collaborative, and independent learning environment. Settings that can facilitate the development of 21st century skills. Students today must combine these skills with the effective use of technology to succeed in current and future jobs. Therefore, based on the statement, suggestions for further research are: (1) how to compile communicative teaching materials through application programs so that they can be used in online learning and (2) how to develop guidance programs for students who have difficulty learning with online learning.

Ethical Statement:

This research was carried out in accordance with the journal's ethical policy. Informed consent to participate in the study was obtained from participants (or their parent or legal guardian in the case of children under 16) by the relevant school leadership.

References

Commented [U12]: 1. Please provide at least **30 references** which 80% of them are taken from **the last 10 years (>2011)** articles of no-predatory journals, written in accordance with the APA Standard. You may go to Google Scholar and find the right format for APA Style provided.

2. For books, please refer to the original/primary book reference no matter the date.

3. All of the listed references must be cited in the body of the article, and vice versa.

Anderson,L.W & Krathwohl, D.R (ed).,2010, *A Taxonomy for Learning, Teaching, and Assesing:* A Revision of Bloom Taxonomy of Educational Objectives. Diterjemahkan oleh Prihantoro, Pustaka Pelajar, Yogyakarta.

Arends.R.I. 2010. *Learning To Teach.* Diterjemahkan oleh Soetjipto,H.P & Soetjipto, S.M. 2008, Pustaka Pelajar Yogyakarta.

Bukoye.R.O, (2008) Utilization of Instruction Materials as Tools for Effective Academic Performance of Students: Implications for Counselling, Presented at the 2nd Innovative and Creative Education and Teaching International Conference (ICETIC2018), Badajoz, Spain, 20–22 June 2018.

Brophy, J. E. (2010). Motivating students to learn, Routledge

Brown, M.C, Mcneil., N.M &Glenberg, A.M(2009). Using concreteness in education; real problems, potential solutions. Child development perspectives, 3(3),160-164. http://dx.doi.org/10.111/j. 1750-8606.2009.000

Coskun, A., 2010., The Effect of Metacognitive Strategy Training on The Listening performance of Beginner Student, *Novitas Royal, 4(1), 35-50*

Dawson, T.L., 2008., Metacognition and Learning in Adulthood, *Prepared in response to tasking from ODNI/CHCO/IC Leadership Development Office. Development Service, LLC*

Dhull P & Verma, G. (2020) Use of Concept Mapping for Teaching Science. The International journal of analytical and experimental modal analysis Volume XII, Issue III, March/2020 ISSN NO:0886-9367.
Duque, D.F., Baird, J.A., & Posner, M.I, 2000, Executive Attention and Metacognitive Regulation., *Consciousness and Cogniton 9, 288-307.*
Frelberg, H.J. and Driscoll, A. (1992). Universal Teaching Strategies. Boston: Allyn & Bacon.
Giancoli.D.C (2014). Fisika Edisi 7 Penerbit Erlangga, Jakarta.Indonesia
Gilbert, J.K., Watts, D.M. & Osborne, R.J. (1982). Students' conceptions of ideas in mechanics. Physics Education, 17, 62-66.
Gunstone, R.F. & White, R.T. (1981). Understanding of gravity. Science Education, 65, 291- 299.
Jonassen, D. H. (1991). Objectivism versus constructivism: do we need a new philosophical paradigm? Educational Technology Research and Development, 39 (3), 5-14.
Kerr, C., & Lloyd, C. (2008). Pedagogical learnings for management education: Developing creativity and innovation, Journal of Management and Organization,14(5), 486-503.
Kim M, Cheong Y, & Song J, (2018) The Meanings of Physics Equations and Physics Education, Journal of the Korean Physical Society, Vol. 73, No. 2, pp. 145~151
Langley, D., &Eylon, B. S. (2006). Probing High School Physics Students' Views and Concerns about Learning Activities. International Journal of Science and Mathematics Education, 4(2),215-239.
Lederman, N. G. (2006). Research on nature of science: Reflection on the past, anticipations of the future foreword. Asian-Pacific Forum on Science Learning and Teaching, 7(1), 1–11.

Lee, M & Baylor, A.L, 2006., Designing Metacognitive Map for Web-Based Learning. *Educational Technology & Society, 9(1), 344-348.*
Lewis, B. (2019) TLM: Teaching/Learning Materials. https://www.thoughtco.com/tlm-teaching-learning-materials-2081658
Lin, X. 2001., Designing Metaconitive Activities, *ETR&D, Vol.49, No.2, 23-40.*
Marzano, R. J. (2003). What works in schools: Translating research into action? Alexandria, VA: ASCD.
Michalsky, T., Mevarech, Z. R., & Haibi, L. (2009). Elementary school children reading scientific texts: Effects of metacognitive instruction. The Journal of Educational Research, 102(5), 363–376. https://doi.org/10.3200/JOER.102.5.363-376.
Napoli, R. D. (2004). What is student-centered learning? Educational Initiative Centre University of Westminster
Ozsoy & Ataman., 2009., The Effect Metacognitive Strategy Training on Mathematical Problem Solving Achievement, *International Electronic Journal of Elementary Education, Vol.1, December., p.43-57.*
Pennequin, V., Sorel, O., Nanty, I., & Fontaine, R. (2010). Metacognition and low achievement in thematics: The effect of training in the use of metacognitive skills to solve mathematical word problems. Thinking & Reasoning, 16(3), 198-220. https://doi.org/10.1080/13546783.2010.509052.
Pithers, R. T. (2002). Cognitive learning styles: A review of field dependence-independent approach. Journal of Vocational Education and raining, 13(4), 267-279.
Ramsden, J. M. (1998). Mission impossible? Can anything be done about attitudes to science? International Journal of Science Education, 20(2), 125-137.
Rebecca, L. (2003). Language Learning Styles and Strategies: An Overview. Online publication. Retrieved November2 0 , 2 0 1 2 f r o m web.ntpu.edu.tw/~language/workshop/read2.pdf.
Riding, R & Douglas.G, (1993),The effect of cognitive style and mode of presentation on learning performance, https://doi.org/10.1111/j.2044-8279.1993.tb01059.x
Romizsowski, A. J. (2008) Developing Auto-Instructional Materials. New York: Routledge
Santrock, J.W. 2007. *Educational Psychology.* Diterjemahkan oleh B.S Wibowa.T, 2010, Jakarta: Kencana Prenada Media Group
Shanon S.V. 2008., Using Metacognitive Strategies and Learning Style to Create Self-Directed Learners. *Institute for Learning Style Journal, Volume 1,14-27.*
Stoica I, Moraru S, & Miron C, (2011). Concept Maps, a Must for The Modern Teaching-Learning Process, Romanian Reports in Physics, Vol. 63, No. 2, P. 567–576.
The North American Council for Online Learning and the Partnership for 21st Century Skills November (2006) Virtual Schools and 21st Century Skills, https://files.eric.ed.gov/fulltext/ED514436.pdf
Torkamani H.T. 2010., On the Use of Metacognitive Strategies by Iranian EFL Learners in Doing Various Reading Task Across Different Proficiency Level., *International Journal of Language Student, Vol.4(1), 47-58*
Veenman M.V.J. Wolters B.H.A.M., & Afflerbach P., 2006., Metacognition and Learning: Conceptual and Methodological Consideration., *Metacogniton and Learning 1: 3-14*
Wernke S. Wagener U., Anschuetz A. & Moschner B. 2011., Assessing Cognitive and Metacognitive Learning Strategies in School Children: Conduct Validity and Arising Questions. *The International Journal of Research and Review, Volume 6 Issue, 2: 19-37*

Paper title:

Implementation of Metacognitive Knowledge-Based Physics Teaching Materials Through Online Learning During the Pandemic Covid-19

Parts of review	Guidelines	Yes	Partly	No	Reviewer's note for improvement	Author's responds (highlight of revision)
Title	• Does the subject matter fit within the scope of journal?	√				
	• Does the title clearly and sufficiently reflect its contents?	√				
Abstract	• Does the abstract contain informative, including Background, Methods, Results and Conclusion?	√				
Back-ground	• Is the background informative and sufficient (include the background problem and objectives)?	√				
	• Is research question of the study clear and understandable?	√				
	• Does the rationale of the study clearly explained using relevant literature?	√				
	• Is the "aim" of the manuscript clear and understandable?	√				
Methods	• Is the methodology chosen suitable to the nature of the topic studied?	√				
	• Is the methodology of the research described clearly?(including study design, location, subjects, data collection, data analysis)	√				
	• Is there adequate information about the data collection tools used? (only for empirical studies)	√				
	• Are the validity and reliability of data collection tools established? (only for empirical studies)	√				
	• Are the data collection tools suitable for the methodology of the study? (only for empirical studies)	√				
Results & Discussion	• Are the tables, graphs and pictures understandable, well presented and numbered consecutively?		√		The discussion is still not analyzed sharply.	
	• Do the data analysis and the interpretation appropriate to the problem and answer the objectives?		√			
	• Does the "discussion" section of the manuscript adequately relate to the current and relevant litarature?		√			
	• Are the findings discussed adequately considering the research question(s), sub-question(s) or hypothesis?		√		Partly	
Conclusion	• Is the conclusion clear and in the form of a narration instead of pointers?	√				
	• Isn't the conclusion a summary and		√			

	consistent between problems, objectives and conclusion?					
Reference s	• Do the references and citations match?	√				
	• Are the writing of references correct?			√		
Quality Criteria	• Do the title, problem, objectives, methods and conclusion are in line? Is it well organized?		√			
	• The quality of the language is satisfactory		√			
	• The work relevant and novel		√			
	• Are there strong consistencies among the parts of the manuscript? (introduction, methods, results and discussion, and conclusion)		√			

JPII 10 (2) (2021) 247-255

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

Notes:

1. The characteristic of material teaching developed under metacognitive knowledge based has to be more specified (Performance, indicators of metacognitive knowledge will be trained). Not only in exercise …
2. There is no reason why gender should be a concern in this research
3. The information in article can be enlarge with the breakdown score metacognitive knowledge into indicators….
4. Axis legend should be included in the pictures
5. Abstract: do not use the statistical language to state the conclusion….
6. Suggesting tittle: The implementation of physics learning through online mode during pandemic covid-19 using Metacognitive Knowledge-Based materials

Implementation of Metacognitive Knowledge-Based Physics Teaching Materials through Online Learning during the Covid-19 Pandemic

DOI:

Accepted:… .Approved: … . Published: …

This study aims to analyze the effect of metacognitive knowledge-based physics teaching materials (MKBPTM) on metacognitive knowledge analysis skills. This teaching material was applied through online learning during the COVID-19 pandemic. The research design used a post-test-only control group. Two groups were used: the experimental group totaling 120 students and the control group totaling 124 students. Students aged 15 to 17 years old and came from public senior high schools. The results showed that the mean score of metacognitive knowledge analysis skills (MKAS) in the experimental group was 13.24 (20) and the control group was 8.83 (20). The hypothesis testing results indicate a difference in the average MKAS value obtained by the two groups at the confidence level α=0.05. The results show that MKBPTM has an influence on MKAS compared to conventional-based teaching materials (CBPTM).

Keywords: Analytical skills, MKAS, Teaching materials, Metacognitive knowledge

INTRODUCTION

Physics is a basic science that deals with nature's behavior and structure. Physics is taught to find order through observing nature (Giancoli, 2014). Lederman (2006) states that physics is not just a collection of knowledge, but more than that, science is a way of thinking, a form of investigating, and a body of knowledge. Based on this view, physics is nothing but basic knowledge that studies the behavior of objects, technological products, and natural phenomena that contain the values of life. Kim et al. (2018) suggest that physical equations are needed to study natural behavior. Through equations, the characteristics of natural behavior and their interactions with other natural conditions can be seen. For example, the phenomenon of rain is a natural behavior that does not stand alone. Still, precipitation occurs because of the process of evaporation, sublimation, and melting in addition to other methods.

There are two essential aspects of learning, namely teaching and teaching outcomes. A good education will produce good learning results too. Teaching is a respectable profession where a teacher must make changes in values and knowledge that can be useful for students in facing their daily lives (Bropy, 2010). Kerr and Lloyd (2008) specifically stated that teaching would be more meaningful if concepts, principles, and theories can be turned into practical experiences so that students can understand real situations. Based on these two views, teaching is an activity carried out by the teacher to help students achieve beneficial goals. Therefore, teaching a fun strategy is needed to understand the knowledge and values taught (Rebecca, 2003).

Efforts to achieve teaching goals depend heavily on the use of teaching strategies. A good teaching strategy is a modified strategy. Therefore, nowadays, much research on strategy implementation and testing has been carried out by recent teachers (Jonassen, 1991; Napoli, 2004; Langley & Eylon, 2006). It shows that the importance of teaching strategies is known and understood by teachers. However, many of the new strategies developed by teachers do not use the theoretical basis of student learning and development. Many teachers fail to implement a plan even though the process has been very successful in other schools (Ramsden, 1998). This condition often occurs in teachers in Indonesia. Every learning model applied by the teacher based on the Ministry of National Education policies cannot be adequately implemented because it is not suitable for geographical conditions, environment, culture, and student characteristics. Maybe this learning model is ideal for individual schools but not for other schools. This problem has been going on since Indonesia's independence. Therefore, to overcome this problem, the research team has developed "multi-conceptual based physics teaching materials" as a component of implementing physics teaching strategies during the COVID-19 pandemic.

Why must the teaching materials be developed? The reason is that the teaching strategy is closely related to the teaching materials developed by the teacher. The content of physics teaching materials generally consists of facts, concepts, laws, principles, formulations, theories, postulates, and rules. The more complex the material content, the more complex teaching strategies are required. Teaching materials are learning tools that contain aspects of knowledge to achieve specific learning objectives, as set out in the lesson plan (Lewis, 2009).

Teaching materials are closely related to the dimensions of knowledge. Anderson and Krathwohl (2010) divided the dimensions of knowledge into four dimensions: factual, conceptual, procedural, and metacognitive knowledge. Factual knowledge is knowledge about facts or reality. Several facts which have the same characteristics are called conceptual knowledge. Procedural knowledge is the relationship between concepts.

Meanwhile, metacognitive knowledge is related to the integration of conceptual and procedural knowledge in solving problems. Among the four dimensions of knowledge, the dimension of metacognitive knowledge is the knowledge that must be developed in physics teaching materials. Lin (2001) stated that metacognition is the ability to understand and monitor ways of thinking and their implications for its activities. Metacognition is thinking about thinking (Dawson, 2008; Coskun, 2010; Shanon, 2008).

Metacognition is "*high-order cognition about cognition*" (Veenman et al., 2006; Wernke et al., 2011). Metacognition is a process of thinking about cognitive abilities, cognitive strategies, about cognitive tasks (Duque et al., 2000). This explanation implies that metacognition is more oriented towards higher-order thinking processes, and one of the components of higher-order thinking is critical thinking skills. The statement is in line with Jacobs and Paris (cited in Michalsky et al., 2009), which states that metacognition is "self-awareness of one's knowledge, about one's task, about thinking, and self-control of cognitive processes." Jacob and Paris's statement implicitly implies that people who have good metacognition abilities will automatically think at high levels because controlling cognitive activity will make it easier to perform higher-order thinking skills (Ozsoya & Ataman, 2009; Pennequin et al., 2010).

That is why, in the 21st century, where information technology is rapidly developing, higher-order thinking skills are needed to answer very complex problems.

Meanwhile, Santrock (2007) stated strategic knowledge about how and when to use specific procedures to solve problems. Arends stated the same thing (2010), that metacognitive knowledge is knowledge about learners' cognition and learning about when to use conceptual or procedural knowledge to solve problems. From these two definitions, it can be argued that the leading indicator of metacognitive knowledge is problem-based knowledge. Torkamani (2010) stated that metacognitive knowledge is the knowledge that is used to solve problems (problem-solving). Even more than that, according to Lee and Baylor (2006), metacognitive knowledge is the knowledge that is used to organize and organize thought processes to solve problems. Thus it can be concluded that the characteristics of metacognitive knowledge are problem-solving based.

Based on the explanation above, it can be concluded that it is crucial to teach metacognitive knowledge to optimize students' thinking skills in the 21st century. To make this happen, this dimension of knowledge must be injected into teaching materials. The research team has designed and developed physics teaching materials based on metacognitive knowledge during the COVID-19 pandemic since the beginning of 2000. The development process is through development research procedures and revised three times based on learning experts, material experts, language experts, and experts. Graphics and followed up through focus group discussion activities using the zoom application. At the end of September 2020, it was declared feasible to be implemented through research activities. Implementation in public senior high school students aged around 15 to 17 years. Therefore, the questions in this study are: (1) How big is the KAPM average score obtained by the experimental group students? (2) How big do they control group students to obtain the KAPM average score? (3) Is there a difference in the average KAPM score between students in the experimental group and students in the control group?

Both groups were taught in online learning. What distinguishes is the use of teaching materials. The experimental group used physics teaching materials based on metacognitive knowledge, and the control group was taught using cognitive-based teaching materials. As a summary of the differences between the two teaching materials, the following concept maps are presented in Figure 1.

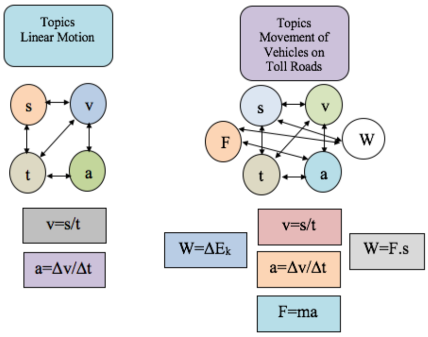


Figure 1. Differences in cognitive and metacognitive based teaching materials

Based on cognitive knowledge, physics teaching materials are teaching materials developed by the teacher based on the material's order in the physics textbook. In Makassar, high school physics teachers in developing physics teaching materials always refer to the book "Physics-Principles With Applications" (Giancoli, 2014). The teacher's physics teaching materials are by order of the material in Giancoli's book. For example, for the subject: One Dimensional Kinematics, the sub-subjects order is reference frame & displacement-Average Velocity-Instantaneous Velocity-Acceleration-Motion at Constan Acceleration-Solving Problems. In a review from the learning aspect, that the arrangement of physics teaching materials like this has weaknesses, namely: (1) It is theoretical and conceptual, (2) Examples of questions developed are limited to the use of formulations (such as s=vt dan a=Δv/Δt), (3) The variables taught are lacking. The development of physics teaching materials like this is called the development of cognitive-based teaching materials. Because this teaching material only emphasizes developing the ability to remember, understand, and apply. At the same time, the aspects of analyzing, assessing, creating are deficient levels.

21st-century learning has changed learning from the cognitive aspect to the metacognitive aspect. Therefore, a paradigm shift is needed to prepare physics teaching materials from cognition-based to metacognition-based. Why? Because only metacognitive knowledge can develop students' thinking abilities, such as the ability to analyze, assess, think critically, and think creatively. The statement is consistent with Santrock's (2007) view that metacognitive knowledge is strategic knowledge about how and when to use specific procedures to solve problems. The same thing was stated by Arends (2010), that metacognitive knowledge is knowledge about learners' cognition and knowledge about when to use conceptual or procedural knowledge to solve problems. There

is a similarity between Arend and Santrock's view,
namely, solving problems. Meanwhile, problem-solving requires the ability to think metacognition (or higher-order thinking). Therefore, the research team has developed physics teaching materials based on metacognitive knowledge. How is the structure of the teaching materials based on metacognitive knowledge?

The scheme for developing physics teaching materials based on metacognitive knowledge is shown in Figure 1 (b) above. The development mechanism is not based on the order of material in the texts-book but events around the students' environment. For example, the topic for the discussion of vehicle movement on the highway is chosen. Of course, many things can be expressed by the motion of vehicles on toll roads, such as the motion of a car that is accelerated slowly, the motion of a constantly driven car, the motion of a car that is ahead of other cars. These incidents were the topic of discussion. In terms of variables to be developed in teaching materials, there are two variables, namely the main variable, which includes speed (v), acceleration (a), distance traveled (s), and travel time (t) (such as s=vt and a=Δv/Δt) and supporting variables such as force (F), work (W), kinetic energy (E). The combination of the primary and supporting variables will enrich the cohesiveness between variables. So that in studying straight motion or vehicle motion, the kinematics aspect (primary variable) is not taught as well as the dynamics aspect (complementary variables).

The advantages of physics teaching materials based on metacognitive knowledge are: (1) students can understand the relationships between kinematic variables and dynamic variables; (2) students have a comprehensive understanding of motion and force; (3) students have no difficulty learning the dynamics of motion because they have introduced earlier in the topic of kinematics, and (4) allows students to develop metacognitive thinking skills. Here is an example of questions from cognitive knowledge-based teaching materials with metacognitive knowledge-based teaching materials such as Table 1 below.

Table 1. Examples of learning materials based on cognitive and metacognitive knowledge

EXAMPLE PROBLEMS ON TEACHING MATERIALS	
Cognitive Knowledge-based Teaching Materials	Metacognitive Knowledge-Based Teaching Materials
The car is driving at a constant 20m/s highway. At 200m in front of the car, a truck overturned. Specify: a. The minimum slowdown of the car so as not to hit the truck. b. car average speed	The car is driving at a constant 20 m/s highway. At 200m in front of the car, a truck overturned. Specify: a. The minimum slowdown of the car so as not to hit the truck. b. car average speed c. If the mass of the car is 1000kg, determine the amount of braking force. d. The effort by the braking force e. The maximum kinetic energy of the car
Note: This example problem only introduces the formula: $S=vt$ and $v^2=v_o^2\pm2as$	*Note:* This example problem presents the procedure: $S=vt$, $v^2=v_o^2\pm2as$, $F=ma$, $W=FS$, and $E=½mv^2$

Based on the explanation of these two types of teaching materials, it can be ascertained that physics teaching materials based on metacognitive knowledge will contribute to analyzing metacognitive knowledge compared to physics teaching materials based on cognitive knowledge. Physics teaching materials based on cognitive knowledge can also contribute to students' metacognitive knowledge analysis skills; it is just that the quality is still low. Therefore, to determine that physics teaching materials contain metacognitive knowledge, a measuring tool is needed to measure the teaching material after being applied to students. The measuring instrument is called "*Metacognitive Knowledge Analysis Skill (MKAS)*." This measuring instrument is structured following metacognitive knowledge principles with the following characteristics: (1) Problem-based question statements, (2) containing more than procedural knowledge. The more procedural knowledge in the questions, the higher the level of metacognitive knowledge.

METHODS

To answer the problem formulation above, the method used in this study is a quasi-experimental research design with a "post-test only control group." This study involved two groups of students: the experimental group using MKBPTM and the control group using conventional teaching materials (CBPTM). Both groups used online learning. The experimental group students were from SMAN 2 Makassar, and the control group students were from SMAN 9 Makassar, Indonesia. The age of the students sampled was around 15 to 17 years old. The total number of samples in this study is shown in Table 2.

Table 2. Number of students in each experimental and control group

EXPERIMENT GROUP (SMAN 2 Makassar)		CONTROL GROUP (SMAN 9 Makassar)	
Class Name	The number of students	Class Name	The number of students
Class XI MIA.1	31	Class XI MIA.1	32
Class XI MIA.2	30	Class XI MIA.2	31
ClassXI MIA.3	29	Class XI MIA.3	30
Class XI MIA.4	30	Class XI MIA.4	31
Total	120	Total	124

Meanwhile, the number of physics teachers used as teachers in online learning is four teachers from the experimental group and two teachers from the control group. The four teachers have more than ten years of teaching experience, so they are considered expert teachers.

Before implementing online learning, the research team conducted intensive training on teaching materials, made power points, used zoom (online internet), and used google forms as a learning evaluation tool. Training activities are carried out for eight days of working time. After implementing the training, teachers convey information to students through the WhatsApp Group application to determine online teaching schedules. Each teacher faces two classes, which are done in a scheduled manner according to the provisions of the school schedule. The time required for each stage of online learning is 90 minutes per week and lasts three weeks. In the fourth week, the MKAS test was conducted simultaneously using Google Forms.

RESULTS AND DISCUSSION

When the teaching took place, nothing happened that would spoil this research plan. Everything went according to plan, right up to the data collection stage. The collected data is in the form of 244 answer sheets. The answer sheet is checked and given a score, then analyzed descriptively and inferentially. The processing results to describe a description of the two groups' analytical abilities is shown in Figure 2.

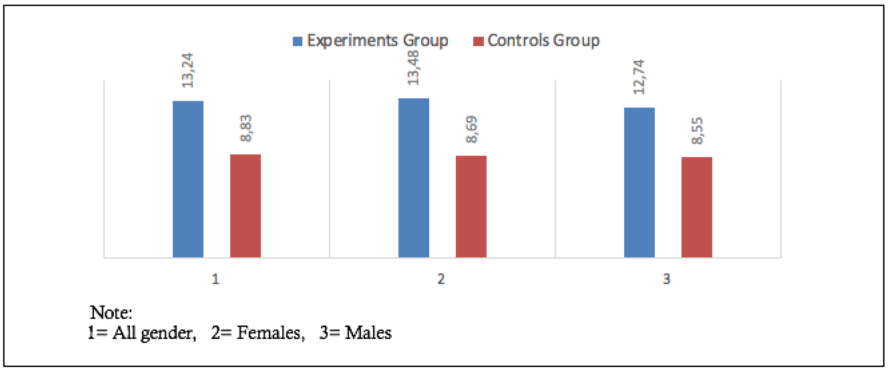


Figure 2. Mean score of the metacognitive knowledge analysis test

It can be seen in the bar chart in Figure-2 that there is a difference in the mean score of the metacognitive knowledge analysis test between the experimental group and the control group. Overall regardless of gender, the mean score of the experimental group was x1 = 13.24 (20) and Sd1 = 4.25, while the control group was x2 = 8.83 (20) and Sd2 = 4.22. Meanwhile, when viewed from gender differences, it turns out that the experimental group was still superior to the control group. The female students' mean score in the experiment group was 13.48 (20), and the control group was 8.69 (20). Likewise, for male students, the experimental group obtained 12.74 (20), and the control group obtained 8.55 (20). So the overall description of the experimental group has better learning outcomes than the control group.

While the results shown in the bar chart in Figure 3 show an overview of the results of the metacognitive knowledge analysis test. The experimental group has a difference in the average score with the control group, where the experimental group is superior to the control group. Likewise, the percentage of students who obtained scores above or equal to 14, the experimental group was still superior to the control group. From these data, it can be concluded that a multi-conceptual-based physics teaching strategy is superior to a mono-conceptual-based physics learning strategy. However, hypothesis testing is still needed to strengthen this conclusion further.

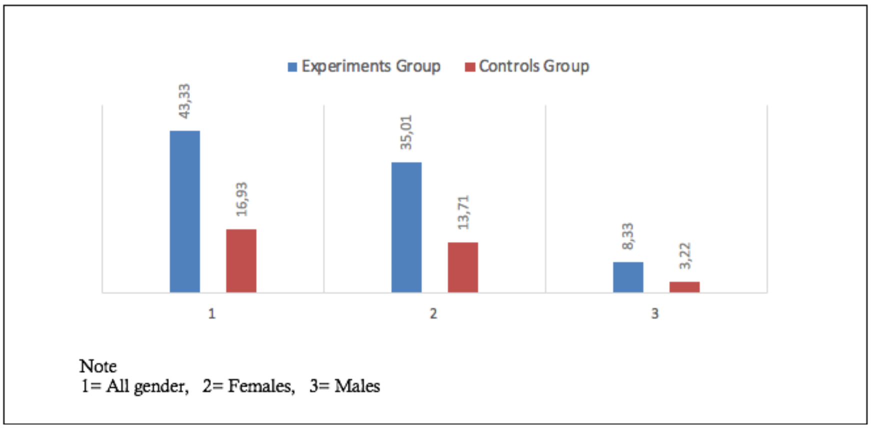


Figure 3. Percentage of students who scored ≥ 14 (maximum score of 20)

As for testing the hypothesis of the difference in metacognitive knowledge analysis test scores between the experimental and control group, the t-test was used. The results of testing data processing are as shown in the following Table 3.

Table 3. Hypothesis testing data

NO	VARIABLE	GROUP	
		Experiment	Control
1	Number of the sample (n)	120	124
2	Average Skor (X)	13.24	8.83
3	Standard Deviation (S)	4.25	4.22
4	Variants (S^2)	18.06	17.81
5	t_{table} for degrees of freedom (n_1+n_2-2) = 242 dan α=0.05	1.97	
6	t_{value}	8.50	

Based on the information on the hypothesis testing data in Table 3, the results show that t = 8.50> t table = 1.97. This test reinforces the above description statement, that overall, a multi-conceptual based physics teaching strategy has an advantage over the ability to analyze metacognitive knowledge compared to a mono-conceptual based physics teaching approach.

Although there are limitations in this study, the difference in the average MKAS score of the student group using MKBPTM and the student group using BAK is an indication that the use of MKBPTM is relatively good in growing MKAS. It means that overall the two groups received the same treatment except for different physics teaching materials. Thus, it can be stated that MKBPTM can relatively grow MKAS. Therefore, it is natural that learning experts believe that the preparation of teaching materials largely determines the success of a lesson through alignment between individual differences and learning objectives (Riding & Douglas 1999; Pitchers, 2002).

Teaching strategies are primarily used to apply learning theory in useful ways and achieve targeted learning outcomes (Miller & Veatch, 2010). On the other hand, Marzano (2003) states that the primary component that affects student learning outcomes is the teaching strategy. However, the success of the system is determined

253

mainly by the development of teaching materials. That is why the teaching strategy and teaching materials are not separated. Both form a unity as the main component in learning.

Therefore, for the teaching strategy to be achieved optimally, the teaching materials developed must facilitate student learning (Romiszowski, 2008). The purpose of facilitating is to direct and guide students to be able to think at higher levels, in line with the suggestion by Dhull and Verma (2020) that physics is a complex subject that requires the use of skills, such as critical thinking, logical thinking, and problem-solving skills. To possess these skills, the teacher must do strategic planning based on the characteristics of physics lessons. One of the characteristics of knowledge that can foster higher-order thinking skills is metacognitive knowledge, as stated in the introduction. Based on the expert's view expressed above, the description of physics teaching materials based on metacognitive knowledge is stated in the knowledge tree diagram shown in Figure 4.

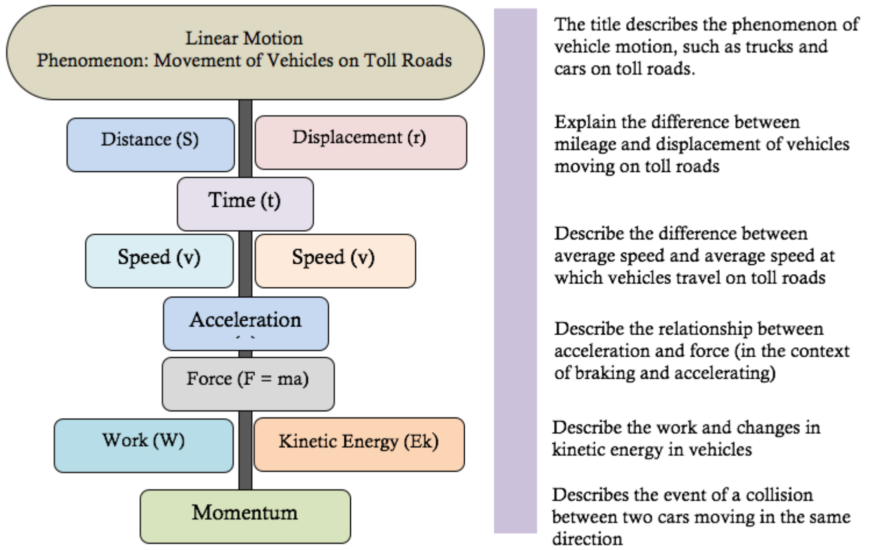


Figure 4. Tree diagram of material content as teaching plan ideas

The development of physics teaching materials must refer to concrete objects and everyday events because it will help students connect abstract concepts and the real world (Brown et al., 2009). As seen in the knowledge tree diagram above, vehicles' movement on toll roads is an everyday occurrence full of concepts and procedures and the relationship between ideas and techniques. It is the basic principle of metacognitive knowledge. The relationship between concepts and methods is discussed in an everyday event (Stoica et al., 2011). Thus, the development of physics teaching materials based on metacognitive knowledge is a strategy that effectively supports the 21st-century learning paradigm.

There are two variables involved in this research: physics teaching materials based on metacognitive knowledge and MKAS. When online learning occurs, there are many reports of internet network disruptions experienced by students and teachers. Conditions sufficiently affect the results of the study. Also, the atmosphere of students studying at home is very much influenced by the needs of the student's home environment and the student's psychological factors. So the researchers consider that the average MKAS score obtained by the experimental group is 13.24 and the control class is 8.83, not entirely due to the treatment is given. This is the limitation experienced by the research team while researching the COVID-19 pandemic.

Physics teaching materials based on metacognitive knowledge are a model of learning materials needed in the 21st-century learning era that promotes critical, creative, communication, and collaboration thinking. The results of the research will significantly help physics teachers how to develop physics teaching materials to support 21st-century learning. Also, the implementation of online learning during the study has provided many skills to use internet technology, especially how to make teaching materials in application programs, such as power points, and how to use online learning applications, such as Zoom, and make assessments via a google form.

CONCLUSION

Teaching strategies can be used to achieve various learning objectives. Meanwhile, the teaching strategy is closely related to the development of teaching materials. Even the teaching material is a scenario of a teaching strategy. One of the failures of students being unable to solve problem-based or metacognitive knowledge-based problems is students' difficulty connecting concepts and procedures. This fact shows that the teaching materials used are more theoretical or traditional. Teaching materials are essential tools in studying every subject in the school curriculum. They allow students to interact with words, symbols, and ideas in ways that develop their ability to read, listen, solve, see, think, speak, write, use media and technology (Bukoye, 2008). Based on the findings in this study and the views of learning experts, it can be concluded that teaching materials (including MKBPTM) are the main components in learning that much determine the achievement of learning outcomes.

This research is exciting, namely, the implementation of physics learning during the COVID-19 period through online learning. So, it is as if the Covid outbreak can be overcome, then online education is only a memory for schools that have been holding classroom learning. This statement has some truth in it, but it should be noted that education development will lead to efficiency and effectiveness in the future. Especially now, the development of communication technology is very fast, so that one-day online learning will become companion learning for classroom learning. Online learning through virtual schools is one of the most critical advances in efforts to rethink the effectiveness of education. The virtual school provides access to an online, collaborative, and independent learning environment. That settings can facilitate the development of 21st-century skills. Students today must combine these skills with the effective use of technology to succeed in current and future jobs. Therefore, based on the statement, suggestions for further research are: (1) how to compile communicative teaching materials through application programs so that they can be used in online learning and (2) how to develop guidance programs for students who have difficulty learning with online learning.

REFERENCES

Anderson,L.W & Krathwohl, D.R (ed).,2010, *A Taxonomy for Learning, Teaching, and Assesing:* A Revision of Bloom Taxonomy of Educational Objectives. Diterjemahkan oleh Prihantoro, Pustaka Pelajar, Yogyakarta.

Arends.R.I. 2010. *Learning To Teach.* Diterjemahkan oleh Soetjipto,H.P & Soetjipto, S.M. 2008, Pustaka Pelajar Yogyakarta.

Bukoye. R.O, (2008) Utilization of Instruction Materials as Tools for Effective Academic Performance of Students: Implications for Counselling, Presented at the 2nd Innovative and Creative Education and Teaching International Conference (ICETIC2018), Badajoz, Spain, 20–22 June 2018.

Brophy, J. E. (2010). Motivating students to learn, Routledge

Brown, M.C, Mcneil., N.M &Glenberg, A.M(2009). Using concreteness in education; real problems, potential solutions. Child development perspectives, 3(3),160-164. http://dx.doi.org/10.111/j. 1750-8606.2009. 000

Coskun, A., 2010., The Effect of Metacognitive Strategy Training on The Listening performance of Beginner Student*, Novitas Royal, 4(1), 35-50*

Dawson, T.L., 2008., Metacognition and Learning in Adulthood, *Prepared in response to tasking from ODNI/CHCO/IC Leadership Development Office. Development Service, LLC*

Dhull P & Verma, G. (2020) Use of Concept Mapping for Teaching Science. The International Journal of analytical and experimental modal analysis Volume XII, Issue III, March/2020 ISSN NO:0886-9367.

Duque, D.F., Baird, J.A., & Posner, M.I, 2000, Executive Attention and Metacognitive Regulation., *Consciousness and Cognition 9, 288-307.*

Frelberg, H.J. and Driscoll, A. (1992). Universal Teaching Strategies. Boston: Allyn & Bacon.

Giancoli.D.C (2014). Fisika Edisi 7 Penerbit Erlangga, Jakarta.Indonesia

Jonassen, D. H. (1991). Objectivism versus constructivism: do we need a new philosophical paradigm? Educational Technology Research and Development, 39 (3), 5-14.

Kerr, C., & Lloyd, C. (2008). Pedagogical learnings for management education: Developing creativity and innovation, Journal of Management and Organization,14(5), 486-503.

Kim M, Cheong Y, & Song J, (2018) The Meanings of Physics Equations and Physics Education, Journal of the Korean Physical Society, Vol. 73, No. 2, pp. 145~151

Langley, D., &Eylon, B. S. (2006). Probing High School Physics Students' Views and Concerns about Learning Activities. International Journal of Science and Mathematics Education, 4(2),215-239.

Lederman, N. G. (2006). Research on nature of science: Reflection on the past, anticipations of the future foreword. Asian-Pacific Forum on Science Learning and Teaching, 7(1), 1–11.

Lee, M & Baylor, A.L, 2006., Designing Metacognitive Map for Web-Based Learning. *Educational Technology & Society, 9(1), 344-348.*

Lewis, B. (2019) TLM: Teaching/Learning Materials. https://www.thoughtco.com/tlm-teaching-learning-materials-2081658

Lin, X. 2001., Designing Metacognitive Activities, *ETR&D, Vol.49, No.2, 23-40.*

Marzano, R. J. (2003). What works in schools: Translating research into action? Alexandria, VA: ASCD.

Michalsky, T., Mevarech, Z. R., & Haibi, L. (2009). Elementary school children reading scientific texts: Effects of metacognitive instruction. The Journal of Educational Research, 102(5), 363–376. https://doi.org/10.3200/JOER.102.5.363-376.

Napoli, R. D. (2004). What is student-centered learning? Educational Initiative Centre University of Westminster

Commented [U1]: Please use APA style and sources from the last ten years.

Ozsoy & Ataman., 2009., The Effect Metacognitive Strategy Training on Mathematical Problem Solving Achievement, *International Electronic Journal of Elementary Education, Vol.1, December., p.43-57.*

Pennequin, V., Sorel, O., Nanty, I., & Fontaine, R. (2010). Metacognition and low achievement in thematics: The effect of training in the use of metacognitive skills to solve mathematical word problems. Thinking & Reasoning, 16(3), 198-220. https://doi.org/10.1080/13546783.2010.509052.

Pithers, R. T. (2002). Cognitive learning styles: A review of field dependence-independent approach. Journal of Vocational Education and raining, 13(4), 267-279.

Ramsden, J. M. (1998). Mission impossible? Can anything be done about attitudes to science? International Journal of Science Education, 20(2), 125-137.

Rebecca, L. (2003). Language Learning Styles and Strategies: An Overview. Online publication. Retrieved November2 0 , 2 0 1 2 f r o m web.ntpu.edu.tw/~language/workshop/read2.pdf.

Riding, R & Douglas. G, (1993), The effect of cognitive style and mode of presentation on learning performance, https://doi.org/10.1111/j.2044-8279.1993.tb01059.x

Romizsowski, A. J. (2008) Developing Auto-Instructional Materials. New York: Routledge

Santrock, J.W. 2007. *Educational Psychology.* Diterjemahkan oleh B.S Wibowa.T, 2010, Jakarta: Kencana Prenada Media Group

Shanon S.V. 2008., Using Metacognitive Strategies and Learning Style to Create Self-Directed Learners. *Institute for Learning Style Journal, Volume 1,14-27.*

Stoica I, Moraru S, & Miron C, (2011). Concept Maps, a Must for The Modern Teaching-Learning Process, Romanian Reports in Physics, Vol. 63, No. 2, P. 567–576.

The North American Council for Online Learning and the Partnership for 21st Century Skills November (2006) Virtual Schools and 21st Century Skills, https://files.eric.ed.gov/fulltext/ED514436.pdf

Torkamani H.T. 2010., On the Use of Metacognitive Strategies by Iranian EFL Learners in Doing Various Reading Task Across Different Proficiency Level., *International Journal of Language Student, Vol.4(1), 47-58*

Veenman M.V.J. Wolters B.H.A.M., & Afflerbach P., 2006., Metacognition and Learning: Conceptual and Methodological Consideration., *Metacognition and Learning 1: 3-14*

Wernke S. Wagener U., Anschuetz A. & Moschner B. 2011., Assessing Cognitive and Metacognitive Learning Strategies in School Children: Conduct Validity and Arising Questions. *The International Journal of Research and Review, Volume 6 Issue, 2: 19-37*

Submit hasil revisi, Keputusan Review: Accepted with revision

Peer Reviewer
Guide for Authors
Online Submission Here
Contact Us

User

You are logged in as...
jasruddin

» My Journals
» My Profile
» Log Out

COLLABORATE WITH

82817337

Peer Review

Round 1

Review Version	28583-72532-1-RV.docx 2021-01-19
Initiated	2021-04-13
Last modified	2021-07-05
Uploaded file	Reviewer A 28583-76152-1-RV.docx 2021-04-14 Reviewer B 28583-77811-2-RV.docx 2021-05-24

Editor Decision

Decision	Revisions Required 2021-04-15
Notify Editor	Editor/Author Email Record No Comments
Editor Version	None
Author Version	28583-76435-1-ED.docx 2021-04-25 Delete 28583-76435-2-ED.pdf 2021-04-25 Delete 28583-76435-3-ED.docx 2021-07-05 Delete 28583-76435-4-ED.docx 2021-07-05 Delete 28583-76435-5-ED.docx 2021-07-05 Delete
Upload Author Version	Browse... No file selected. Upload

Publish

COLLABORATE WITH

Status

Status	Published Vol 10, No 2 (2021): June 2021
Initiated	2021-06-30
Last modified	2021-07-30

Submission Metadata

Authors