THE ROLE OF THE "KNOWLEDGE SKETCH STRATEGY" TOWARDS THE UNDERSTANDING OF METACOGNITIVE KNOWLEDGE

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ABSTRACT
This study aims to apply "Knowledge Sketch Strategy (KSS)" in the teaching of physics in physics master program graduate student of Makassar State University. The expected result is through the implementation of teaching strategies that the students have the ability to understand metacognitive knowledge. The research design was "post-test only control group design". For this purpose, there are two research groups, ie the experimental group that is given knowledge sketch strategy teaching, and the control group that is given teaching strategy in the form of "Known-Asked Strategy (KAS)". The data analisys shows that the experimental group has the average score of 8.41 and the control group is 4.33. This result indicates that the KSS is better used as the physics teaching strategy than KAS to understanding of metacognitive knowledge in learning physics.
Keywords: metacognitve knowledge, teaching strategy, and learning physics.

INTRODUCTION

In the start of 2015/2016 academic year, the new students of physics education program were given essay test of parabolic motion unit at the first lecture. This test aims to determine the ability to understand the concepts of physics that they had learned during school. The result is from 26 students tested, none of the students can answer correctly75.0% from maximum score of 10.This result indicates that the students' understanding of the concept of parabolic motion is very low. This also means that their metacognitive knowledge is lacking. Kim, B., Park, .H,.& Baek, Y., (2009) states that metacognitive knowledge is important for learners in understanding the material and improving the level of higher-order thinking

It is suspected that it happened because in the middle school they were rarely taught metacognitive knowledge. According to Widodo (2008) that most teachers only teach the simple factual, conceptual, and procedural knowledge but they seldom teach the metacognitive knowledge. One reason is that even physics teachers lack metacognitive knowledge. This has been proven through the provision of parabolic motion unit test to 32 physics teachers from the alumni of Makassar State University who are joining the matriculation program of physics education magister in Makassar State University academic year of 2015/2016. The results are 8 teachers (21.9%) have above 75% correct answers, the rest, 24 teachers (78.1%) have below 75% correct answers (Abdullah, 2014) .The inability of teachers to answer the test also indicates that teachers' knowledge in metacognitive is still low.

Based on these facts, it can be assumed that the inability of students to answer about parabolic motion because when they were studying in high school, they were rarely taught metacognitive knowledge. Why is that? Because based on the above facts, teachers also lack the mastery of metacognitive knowledge, especially related to the teaching of physics. Thus, researchers assume that physics teachers have been taught or trained about the problems of learning models, teaching theories, how to plan lessons, how to manage classes, how to organize worksheets, how to make evaluations, but they are seldom trained on their student about strategy for solving higher-order physics problems. Though one indication of student success is determined by the ability to solve physics problems.

Researchers found that the pattern of solving physics problems that physics teachers had been using was the "known-asked strategy (KAS)". According to Abdullah.H, Bunda.P, D. Malago. J & Thalib. S.B, (2013), this strategy can be applied to questions of the use of formulas, but it is very difficult to apply if they have demanded the translation of equations. The researcher will write two physics problems that have been used as a tool to know the understanding of metacognitive knowledge.

Table-1: Two different physics problems of difficulty level

Problem-1	Problem-2
A motorcyclist, suppose when t=0 speed is 10m/s (36km/h), after moving for 10s to 20m/s (72km/h). What is the distance traveled by the rider during 10s?	A tank was storming into a military base. The tank is moving at a speed of 20m/s (72km/h). A soldier in a 35m high-alert tower got ready to open fire. The cannon is set at an angle of 37^o horizontally. If the initial velocity of the cannonball is 50m/s. Determine at what distance the tank is from the foot of the tower is fired so that the tank is hit by the cannonball?

It is seen in Table-1 that both problems have different characteristics and difficulties. For problem-1, almost all students can solve it by using KAS, but at the time of completing problem-2, all students cannot solve the problem by using KAS. Why did it happen? Because KAS is very difficult in detecting latent variables or principles in the problem. KAS is only able to identify the clear variables written in the problem as in the above problem-1. While in problem-2 there are latent variables or principles that are not clearly written in the matter of the issue of the time the cannonball moving toward the target point is equal to the time the tank is moving toward the target. This variable is very difficult to detect by KAS.

Based on the above problems, the researcher has implemented a problem solving strategy called "Knowledge Sketch Strategy (KSS)". This strategy has been used to Physics Education Studies students who are programming basic physics courses (matriculation program). The purpose of this KSS implementation is in addition to training the master of education physics program (prospective teachers and teachers) on how to solve physics problems with KSS, is also to know its role to the formation of "metacognitive knowledge" of students. Therefore, the question in this study is "*how is the score of understanding of metacognitive knowledge of university physics education master program student of Makassar State University, taught by using KAS and taught by KSS?*"

THEORITICAL FRAMEWORK

In relation to metacognition, Schneider, W., (2008) states one of the main aspects of metacognition is metacognitive knowledge. Duque,D.F., Baird,J.A., & Posner,M.I,. (2000) states metacognitive knowledge is knowledge of cognitive ability, cognitive strategies, and cognitive tasks. Whereas, Santrock, J.W (2004) states that, metacognitive knowledge involves monitoring and reflecting on one's mind, including factual knowledge, such as knowledge of tasks, goals, or self, and strategic knowledge (such as how and when to use specific procedures to solve problems). Arends (2007) mentions that metacognitive knowledge is knowledge of cognition and when to use conceptual and procedural knowledge to solve problems.

Based on the above explanation, metacognitive knowledge is the knowledge of the cognitive processes used to solve problems based on the factual, conceptual and procedural knowledge they possess. Thus, any problem will be difficult to solve if one has no factual, conceptual and procedural knowledge related to the problem. On the other hand, although a student possesses these three pieces of knowledge but rarely used them to solve complex problems, his/her knowledge is difficult to develop into metacognitive knowledge.

Nowadays, the learning paradigm no longer leads to mastery of "text-book" material, but how through the learning material, the learners have the skills of thinking and insight or have metacognition strategy in solving the problem. For this, the learning of metacognitive knowledge becomes very important. Santrock, J.W, (2004) states that metacognitive knowledge is taught to students to help solve the problems (mathematics as well as physics problems).

Huffaker.D.A, & Calvert, S., (2003), stated that the latest science learning encouraged to design an interesting curriculum that can apply the real world, the practical world that occurs in the community, and the most important is to provide opportunities for learners to learn both in class and out of class. This view implies the importance of teaching metacognitive knowledge for the teaching of science (physics). The same thing is expressed by Vanlehn, K., Burleson, W., Echeagaray, M.E & Christopherson, R. (2011), that teaching using metacognitive strategies is well suited to be developed in physics learning, especially in relation to problem-solving in higher-order physics problems).

In addition, the impact of metacognitive learning is immense for learners as Oxford points out. Torkamani, H.T. 2010.,) state that metacognitive strategies will help learners to organize: (1) themselves as learners, (2) the learning process, and (3) specific learning tasks. The same thing is expressed Okoro.C.O. & Chukwudi, E.K.

(2011) that in teaching, metacognitive knowledge strategies can help students learn to think and draw conclusions from the concepts they learn. Therefore, to realize it in the context of the physics learning, it requires a separate strategy in solving physics problems. The strategy to be developed in the research is "Knowledge Sketch Strategy". This strategy has been developed by Abdullah (2014) as a strategy in basic physics learning.

What is a Knowledge Sketch Strategy? According to Abdullah (2014) that knowledge sketch strategy is a way of solving physics problems using images as sketches of knowledge in translating the problem's language. Specifically, this strategy consists of three stages: (1) **Sketches of Knowledge**, the ability to manipulate problem statements into the form of design drawings that make it easy to identify the associated magnitudes. The mechanism is to sketch the image of the object in the problem both for the initial conditions and as well as the later end condition of the sketch is to determine the magnitude of the accompanying drawing sketch, for example for the vector quantity of the arrow in accordance with its direction. (2) **Formulating** is a process of formulation based on drawing sketches with reference to basic concepts, principles and formulations. (3) **Executing** uses mathematical principles to solve problems based on the formulation described

By scanning the steps in applied the Knowledge Sketch Strategy, then the real phase of the picture also reflects the process of reasoning exercise. That is, if this strategy is taught to learners consistently, then in addition to the understanding of metacognitive knowledge can be achieved, the learners' ability of reasoning will also be honed properly. Scientific reasoning is done inductively and deductively. Inductive reasoning means developing the general rules, principles, and concepts of observation and knowledge of specific examples. Deductive reasoning is to apply the rule of inference to the formal model to decide whether specific examples are in accordance with logic.

METHOD

This research is an quasi exeriment that implements physics teaching strategy called KSS. To see the role of KSS in understanding metacognitive knowledge in physics teaching, another strategy used as comparison is KAS. Therefore, the researcher has assigned as many as 35 students of Physics Education Magister Program of Makassar State University in basic matriculation physics program. Then from 35 students, they are grouped into two classes, 17 students as experimental class and 18 students as control class. Experiment class is taught with KSS and control class with KAS. After four teaching classes, both classes were given a metacognitive knowledge comprehension test.

The limitation of understanding metacognitive knowledge in this research is the ability to organize concepts, principles, laws, and formulations in solving higher-order physics problems. Therefore, based on this indicator, the test used to measure the understanding of metacognitive knowledge is the description test. The number of tests is one problem with the completion time of 45 minutes. While the maximum possible score is 10 and the minimum score is 0.

The process of scoring the results of metacognitive knowledge understanding is done in two ways, which are determining the average score and determining the percentage of the number of students who scored above 80% correct. The result of processing and discussion are described in the following sections.

RESULTS AND DISCUSSION

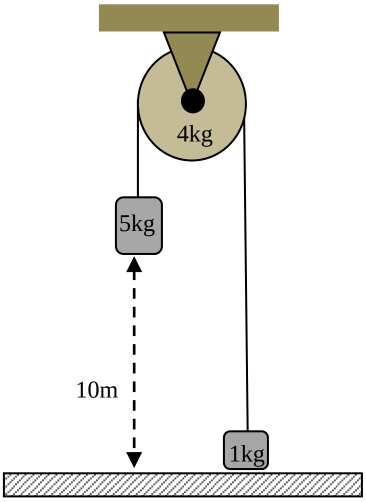
The metacognitive knowledge comprehension scores of experimental class and control class students were processed to determine the average score, the standard deviation, and the percentage of students who scored 80% and above. The processing results are shown in table-2 below.

Table-2: Results of data analysis

Aspects	Experimental Class	Control class
Sample (n)	17	18
Average score ($\bar{x}$)	8.41	4.33
standard deviation(Sd)	1.73	2.49
the percentage of students who scored 80% and above	76.47	16.67

Seen from table-2 above, it turns out the average score obtained from the experimental class is greater than the average score of the control class. Similarly, from the percentage of students who scored above 80%, the experimental class is superior to the control class. Thus it can be argued that the actual strategy of teaching physics by using KSS is much more significant than the KAS in terms of understanding of metacognitive knowledge. Why did it happen? To answer this question the researcher will discuss the process of solving the problem through the following KAS and KSS.

Figure 1. Fixed pulleys and two loads

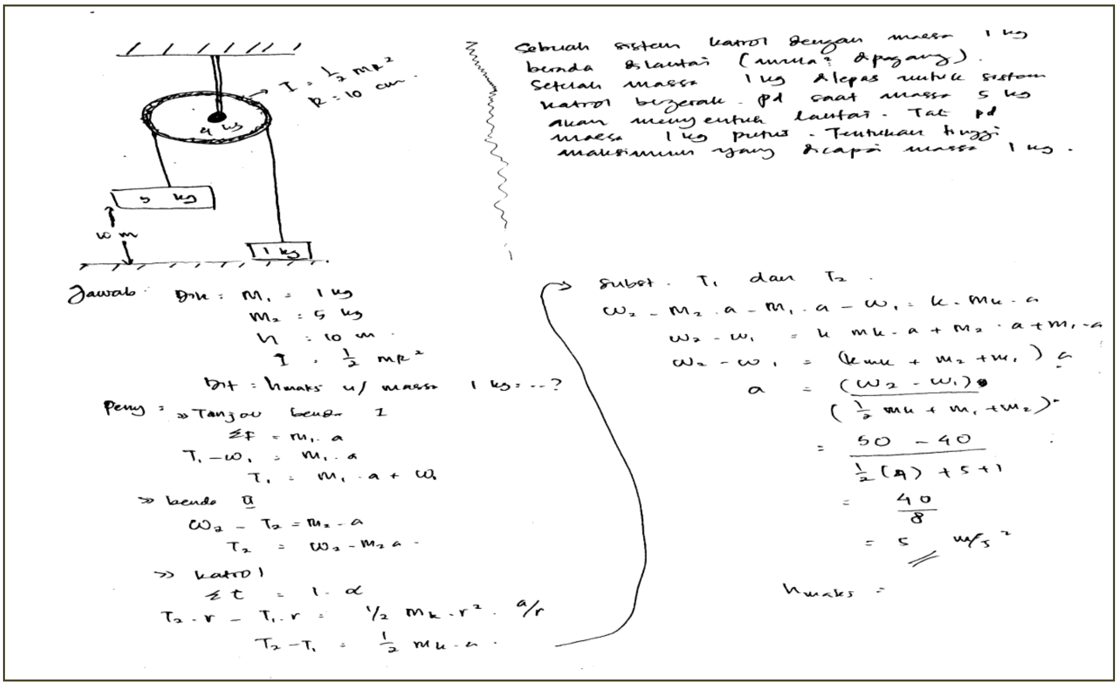


Problem:
A pulley system is shown in the figure 1on the side. Mass m_1 is 1 kg on the floor (held). And mass of m_2 is 5 kg hung as high as 10 m from the floor. The pulley mass is 4 kg. When m_1 is removed from the handle and m_2 moves downward to the floor. After m_2 arrives on the floor, the straps on m_1 break.Determine the maximum height reached by m_1. Asume air friction and mass rope ignored (using g=10 m/s2).

Before the researchers review the problem-solving process by means of KAS and KSS, the researcher cites Abdullah's statement (2014), that the problem-solving strategy generally requires three stages: (1) variable identification, (2) formulation, and (3) mathematical operations (the execution). The difference between KAS and KSS in solving the problem is in the variable identification stage. If KAS uses the "known" way, then KSS uses "picture sketch". For more details can be seen example of the problem in Figure-1, the problem is used to measure the understanding of metacognitive knowledge of students.

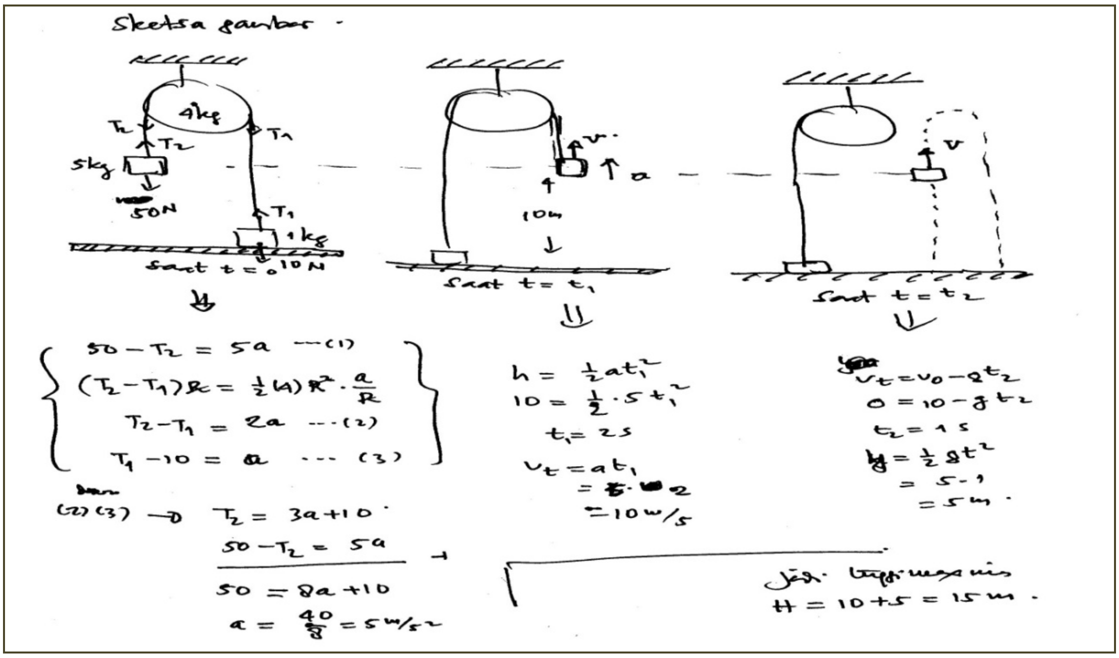
In solving the above metacognitive knowledge problem, according to KAS and KSS that have been selected from the result of problem-solving by the control class students and experimental class are as follows.

Figure 2. solution problem by way of KAS



It can be seen in figure 2, that the solving of KAS problem especially in the stage of identification of variable by way of "known", it gives less information to variable and principle contained in the problem. In this way, only variables listed in quantity can be identified. Whereas in the matter, there are variables and principles contained in the problem that are not well identified. like in system acceleration variables, the speed of m1 when it reaches a height of 10m, and the time to reach the maximum height. Similarly, Newton's second law principle, force moment, vertical motion and free fall motion. As a result, by the way of "known" the student will have difficulty applying the formulation and describe the equation. Here lies the weakness of the completion of physics problems by means of KASs, especially in solving higher-order problems (having metacognitive knowledge).

Figure 3. solution problem by way of KSS



On the other hand if done by using KSS, it will be clearly illustrated the step of the system movement from the moment of t=0, when $t=t_1$and at $t=t_2$, as shown in the completion of the physics problem in figure-3. Look for the displacement image sketch of m1 when t=0 to $t=t_1$, it is easier to use and describe both Newton's law formulation and force moment. So for m1 when it is at a height of 10m, then its speed can be determined. Similarly in the shift of m1 when $t=t_1$to $t=t_2$where the string breaks and m1 moves upward with velocity v to reach the maximum height.

In addition, in terms of aspects of learning, it can be seen the comparison of physics teaching using KAS and KSS. If using KAS, students are actually trained only in the aspect of ability to remember and understand. That is, considering the use of concepts and formulations, but very less developed in other aspects of higher-ability thinking. While the teaching of physics by using KSS, students will be trained to have special abilities such as: (1) **imagination** to change verbal language into sketch form of drawing, (2) **to analyze** the ability to sort out the problem statement into knowledge segments, and (3) **to describe** the equations based on the sketches of the knowledge they draw.

In general, the explanation of the teaching of physics with KAS and KSS on its role in physics learning can be seen in the following table-2.

Table-2

Stage in Solving the Problem	Aspects In Physics Teaching	
	KAS	KSS
Identification	Know and remember variables, concepts, and formulations	Imagine, analyze and design sketches of knowledge in the form of drawings
Formulating	Using Formulation	Use formulations and describe equations based on principles
Executing	Mathematical operations	Mathematical operations

It can be seen from table 2 above that the main difference in problem-solving strategy as a teaching strategy between KAS and KSS lies in the identification stage. In KAS, students are only trained to identify by knowing (remembering) variables, concepts, and formulations. While in KSS, students are trained to translate that matter into the form of sketch drawing for each particular stage. From the process of translating, the student is actually trained in the ability to imagine, analyze, and design drawing sketch. This exercise of ability is the necessary basis for training higher-order thinking skills. It just can not be denied that to plan the teaching of physics by using KSS, a teacher must also have high-order thinking skills, such as preparing questions that require high-order thinking skills and have the KSS ability.

CONCLUSION

One of the most effective ways to solve higher-order physics problems is by KSS. This strategy has advantages compared to KAS, which can identify written variables, hidden variables and basic principles or relationships between events when t=0 and t=t. Viewed from the aspect of learning, the most important goal of teaching by means of KSS is to train the imaginative side by translating the language of the problem (abstract) into a sketch of the image (real). This imaginary ability is very important in physics teaching, because the study of physics is abstract.

RECOMMENDATION

It is fully realized that the study of KSS is still very limited only to the aspects of metacognitive knowledge. Researchers recommend that this KSS can also be studied from the aspect of its role to other thinking skills.

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