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Science Learning Based on Higher Order Thinking Skill and Its Supporting Components

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Abstract: This article is a literature review article related to Higher Order Thinking Skill (HOTS)-based learning and its supporting components as one of the efforts in facing current educational challenges. The purpose of this article is to describe higher order thinking learning and it's supporting components in successful learning. The data collection method used is literature study from various research reference sources and authors. The demand for increasing critical thinking skills can be overcome with real HOTS-based learning. Less than optimal achievement of HOTS-based learning objectives can occur due to lack of attention to supporting components in implementing HOTS-based learning. It is important to know and examine the supporting components in HOTS-based learning, including Teacher Competence, Facilities and Technology, Strategy, Student Motivation. This article provides an overview of how HOTS is applied in learning as well as the important components in the application of HOTS-based learning.

Keywords: Learning Science; HOTS; HOTS Supporting Components

Introduction

The importance of higher order thinking skills (HOTS) has been emphasized by policy makers, educators, researchers and the general public (Abosalem, 2018). Hwang et al. (2017) have identified three HOTS in their research, namely problem solving, critical thinking, and creativity. HOTS is an ability that consists of important skills students will need to prepare for the future. This becomes important for educators to stimulate the development of students' HOTS abilities starting from the classroom environment. Learning in the 21st century focuses on problem solving through education. This requires students' HOTS abilities. HOTS ability is needed because this ability equips students to analyze, evaluate, and create solutions to a problem (Anderson et al., 2001; Garcia, 2015). HOTS must be an ability every student has to prepare themselves to face future challenges and global competition.

Involving students in deeper and more intense thinking about a topic studied in the curriculum is an important part of education. This is part of improving the ability to think at higher levels. Efforts to increase the achievement of students' HOTS abilities require important components that must be carefully prepared, including teacher competence in teaching HOTS, supporting technology and facilities, strategies used and efforts to increase student motivation. Many difficulties are experienced in implementing HOTS-based learning from teachers and students. The demand for increased ability in critical thinking can be overcome with actual HOTS-based learning. Sub optimality in achieving HOTS-based learning objectives can occur due to lack of attention to the supporting components in the implementation of HOTS-based learning. That's why it's important to know and examine the supporting components in HOTS-based learning.

How to Cite:
Example: Susilawati, S., Doyan, A., Muliyadi, L., & Hakim, S. (2019). Growth of tin oxide thin film by aluminum and fluorine doping using spin coating Sol-Gel techniques. *Jurnal Penelitian Pendidikan IPA, 1*(1), 1-4. https://doi.org/10.29303/jppipa.v1i1.264

Method

This research conducted a search for scientific literature related to HOTS and its supporting components in databases such as SINTA, Scopus, and Google Scholar. The method used in this research is document analysis in the form of research articles that examine theory and research results regarding Higher Order Thinking Skills (HOTS) in the form of methods that can be used, teacher competence in teaching HOTS, supporting facilities and technology, and student motivation. The articles searched are the results of national and international journal publications. The criteria for selecting articles are the results of qualitative and quantitative research as well as reputable research articles. Keywords used in the search included "HOTS" and "Science Learning". This search was carried out with the aim of identifying studies that discuss HOTS and its supporting aspects. This study reviewed the titles and abstracts of articles found in the initial search. The articles used are relevant articles according to our inclusion criteria, namely studies involving learning methods, teacher competence, supporting technology and student learning motivation. Data collected from this literature article was analyzed descriptively. This research identified common patterns in the results of the reviewed studies.

Result and Discussion

Higher order thinking skills are students' mindsets that rely on the ability to analyze, create and evaluate all aspects and problems (Zaini, 2015). Success in mastering science concepts is achieved when students are able to think at a higher level. Students not only remember and understand concepts, but can carry out analysis and synthesis, evaluate and create concepts well. Such abilities are known as Higher Order Thinking Skills (HOTS) or high-level thinking skills (Julianingsih et al., 2017). The aim of HOTS is how to improve students' thinking abilities at a higher level, especially related to the ability to think critically in receiving various information, think creatively in solving problems and making decisions in complex situations (Saputra, 2016).

The cognitive process dimensions are arranged sequentially from low level of thinking to high level of thinking, from remembering to creating. HOTS is located at the highest level, namely analyzing, evaluating and creating (Crumpler, 2014). HOTS ability is needed because this ability equips students to analyze, evaluate, and create solutions to problems (Anderson et al., 2001; Garcia, 2015).

Limbach and Waugh (2010) describe steps that can be taken to increase students' HOTS, namely, (1) determining the goals to be achieved, (2) asking probing questions in learning, (3) conducting experiments before assessment, (4)) review, correct and increase understanding through discussion, (5) provide feedback and carry out learning assessments.

Understanding the components that affect HOTS can help in designing lessons that can improve the quality of HOTS-based learning.

Teacher competence

High Order Thinking Skill (HOTS) are thinking abilities that involve students' mental activities in exploring complex, reflective and creative experiences carried out with the aim of gaining knowledge, namely analytical, synthetic and evaluative thinking abilities (Wardana, 2010). HOTS is the ability to connect, manipulate and change the knowledge and experience that students have critically and creatively in determining decisions to solve problems in new situations (Dinni, 2018). According to Brookhart, the concept of Higher Order Thinking Skills can be defined into three different concepts: (1) HOTS as a transfer; (2) HOTS as critical thinking and (3) HOTS as problem solving. In order to fulfill this, the teacher's ability to manage the class is required. Students' ability to think at a higher level is also influenced by the students' abilities.

Teacher competence is very influential on the success of learning, in this context is HOTS-based learning. The study of teacher knowledge in HOTS learning has been studied by Zohar & Schwartzer (2005) which mentions the importance of the study of teacher knowledge in teaching thinking. Teacher knowledge has important implications for professional development. Early knowledge also affects what they will learn and how they apply HOTS learning in teaching practice. Improving students' HOTS becomes difficult if the teacher as a facilitator does not have the intellectual skills and critical thinking skills that will be taught to students. Teachers need to know what it takes to make the transition from traditional teaching centered on information transmission to instructional learning that sees the development of higher order thinking skills.

Zohar & Schwartzer (2005) emphasize that there are three important points in answering these questions, first that teachers need to know various kinds of thinking patterns, skills and strategies at the cognitive and metacognitive levels. At the cognitive level, it means that teachers can use these skills to solve and solve problems. While at the cognitive level means being able to verbally express thought processes and make generalizations and explain when, why and how they use them. Second, knowing how to teach that involves students in tasks that require higher order thinking skills. In order for this to be achieved, it is very important to master the teacher's knowledge of how to apply the

curriculum related to thinking skills and how to plan learning abilities that are rich in these objectives. Third, teachers must have the ability to identify students' reasoning difficulties and ways to overcome them. Fourth, the role of the teacher who is a source of knowledge is replaced with its main role in initiating and training students' inquiry and problem solving. Thus, teachers must learn to replace traditional assessment practices with assessments that are in accordance with HOTS-based learning objectives. The teacher's pedagogical ability in conducting HOTS-based learning must be assessed and class observations are made in order to evaluate the improvement of learning so that it is in accordance with the objectives.

Facilities and Technology

Technology is a tool that enables students to move from knowledge acquisition to knowledge application. The advent of the Information Age has made the development of problem solving, critical thinking, and higher order thinking skills essential for future success (Fontana et al., 1993). When students start using technology resources to manage their learning, the teacher's role is changed from teacher to mentor. The availability of a large amount of easily accessible information frees the teacher from the role of providing facts and allows teachers to encourage students to use computers as a tool for problem solving and decision making.

Kelman (1989) identified higher order thinking skills as one area of learning that can be improved by using computers. (Salomon, 1990) concludes that for computers to be effective classroom tools, "almost everything in the classroom needs to be changed to make curriculum, learning activities, teacher behavior, social interactions, learning objectives, and evaluation intertwined into a new learning environment. Hopson et al., (2001) in their research stated that the creation of a technology-enriched classroom environment had a minimal but positive effect on the acquisition of higher order thinking skills by students. The use of appropriate technology can be a support in efforts to increase student HOTS.

Several studies on HOTS have linked it to the use of 'smart classrooms'. The term smart classroom refers to a physical classroom that has integrated forms of educational technology. An environment with this design provides opportunities for students to learn and participate in learning experiences beyond ordinary classrooms (Macleod et al., 2018). Lu et al. (2021) identified four features of a smart class that can be used as a reference in building a technology-enriched environment. The first is the smart classroom, where technology-rich learning combines physical and virtual classrooms. Second, smart classes provide information and communication technology tools, complete learning resources, and support facilities for various learning activities including personalized learning, collaborative learning, inquiry-based, mobile learning and virtual learning.

Third, storing student data for analysis so as to assist in the process of making optimal pedagogical decisions. Fourth, the environment is open and makes students in an authentic learning context. Smart classrooms stimulate students' learning motivation, encourage active learning and improve academic learning outcomes (Jena, 2013; Liu et al., 2011). Complete facilities in smart classrooms can also be equipped with books or teaching materials that support Hots-based learning. In a study conducted by Ichsan et al., (2020) regarding the implementation of additional green consumerism books can increase students' HOTS in learning. The results show that there are differences in classes that are taught using the supplementary book green consumerism and those who do not. There is an increase in students' HOTS abilities, although not significant, but the use of facilities in the form of books and other facilities specifically designed to meet the needs of achieving HOTS learning objectives is important in an effort to succeed in learning.

Strategy

Efforts to develop HOTS students in a learning environment must consider learning strategies. This is in accordance with research conducted by Lu et al., (2021) that learning strategies have a direct effect on improving students' HOTS, for example in meeting the needs, interests, strategies and learning abilities, educators and instructional designers must incorporate the construction of a smart classroom environment and technology into the learning process.

Learning strategies are also important in improving HOTS. One of them is inquiry based learning. Inquiry learning is based on students' motivation and prior knowledge. One of the objectives of inquiry learning is to introduce HOTS and skills, content knowledge and scientific understanding to students. This inquiry-based learning is able to stimulate the ability to think and work scientifically and trigger an attitude of curiosity and trying to understand the world around (Madhuri et al., 2012).

The study conducted by (Madhuri et al., 2012) shows that inquiry-based learning currently has proven results compared to conventional laboratory approaches. This experience can be more effective if it is integrated with problem-based learning. This result is significant especially in terms of participants' performance to conduct systematic and accurate experiments.

Dede (1990) suggests that higher order thinking skills for structured inquiry are best obtained where

learners build knowledge rather than passively swallow information, sophisticated information-gathering tools are used to stimulate students to focus on testing hypotheses rather than plotting data. There is collaborative interaction with peers, similar to the team-based approach that underlies today's science; and Evaluation systems measure complex high-level skills rather than simply remembering facts.

In addition to inquiry based learning, project based learning is also one of the lessons that can support students' HOTS. Project-based learning uses an approach that involves students in problem solving and freedom of learning and allows more peer interaction. Lu et al., (2021) stated that the interaction between peers and learning motivation has a direct effect on students' HOTS.

Meanwhile, according to Kosasih (2014) states that one of the advantages of project-based learning is increasing student learning motivation. Thus, a learning strategy that emphasizes and allows peer interaction can be a calculated choice. Project based learning is a learning approach that gives students the freedom to plan their learning activities, carry out projects collaboratively and can produce their performance products (Prasetyo & Budiyanto, 2020).

Problem based learning is one of the options that can be used in HOTS-based learning. Problem based learning encourages students to learn in problematic situations, collaborate in groups in finding solutions to problems. Problems given by educators aim to foster student curiosity so that it stimulates students to think critically and analytically and be able to find appropriate learning resources (Amir, 2009).

Discovery based learning can also be an option in teaching HOTS to students. This model is quite effective because it can increase student participation in the learning process, train critical thinking and provide direct learning experience in finding concepts and interacting with the environment (Omrod, 2008). Learning with discovery learning has a positive impact on increasing students' critical thinking skills which is supported by the results of Muslim research (2019). Discovery learning raises positive attitudes of students when building knowledge, collaboration between students, self-confidence, and problem solving, finding solutions and creating new ideas (Prasetyo & Budiyanto, 2020).

Based on the description above, it can be seen that the learning strategies used are mostly useful in increasing student motivation and interaction or collaboration between individuals which is an important factor in efforts to improve students' HOTS abilities.

Student Motivation

Motivation in learning encourages students to achieve goals and fulfill needs and expectations in the learning process (Gopalan et al, 2017). Roberts & Dyer (2005) stated that students' motivation in learning can be associated with HOTS in an online learning environment. The results are the same in the research conducted by Gong et.al (2020) which states that student learning motivation has a direct impact on computational thinking skills which include creativity, algorithms, cooperation, critical thinking and problem solving.

Students with high learning motivation can improve their HOTS ability. Learning motivation is an important component in the success of students in understanding something and the willingness to think and solve problems. This is in line with research conducted by Lu et al., (2021) which states that learning motivation directly impacts students' HOTS. The results of his research indicate that to develop students' HOTS, it is very important for educators to consider students' learning motivation, peer interaction, learning strategies and student preferences.

Conclusion

The development of the times demands critical thinking skills, problem solving and student creativity. This ability can be obtained from HOTS-based learning. The success of HOTS-based learning in improving students' thinking skills cannot be separated from various important supporting components that must be considered, namely teacher competence, facilities and technology, appropriate strategies in learning and learning motivation that exists in students. However, there is a need for a more in-depth study of other important components in supporting the success of HOTS-based learning and research on the relationship between HOTS and the readiness and competitiveness of students in the future.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper

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