JPPIPA 9(8) (2020)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

How to Prepare HOTS to Face the 21st Century?

Jihannita[1*], Zuhdan Kun Prasetyo[1], Insih Wilujeng[1]

[1] Universitas Negeri Yogyakarta, Indonesia.

Received: June 29, 2023
Revised: August 8, 2023
Accepted: August 25, 2023
Published: August 31, 2023

Corresponding Author:
Jihannita
jihannita.2022@student.uny.ac.id

DOI: 10.29303/jppipa.v9i8.2847

Abstract: Higher-order thinking skills (HOTS) have become a focus in the goal of providing education in Indonesia. The purpose of this study is to analyze the extent to which research that seeks HOTS in Indonesia is developed especially in relation to facing the 21st century, at present. The analysis is carried out on articles published nationally and internationally. The analysis was conducted on 26 articles indexed by SINTA and DOAJ. The findings show that research on higher-order thinking skills (HOTS) in Indonesia is dominated by the development of instruments used to measure students' HOTS as well as the application of learning using innovative methods to improve HOTS. Scientific disciplines developed on the basis of higher-order thinking skills are also very diverse with students in universities as a sample that is often used. HOTS is defined as based on the notion of a problem-solving thinking framework, Bloom's cognitive domain and its revisions, and HOTS Climate Change which emphasizes the level of innovation development. Most sample sizes are in the range of 50-100 samples. The most frequently used research design is RnD research.

Keywords: Higher Order Thinking Skills; 21st Century; Review

Introduction

The 21st century is known as the century of knowledge, in which there is a huge information explosion. As a result, all aspects of life have progressed so rapidly, that each individual is required to master various skills. Zibaidah, (2016) explains that among the skills that are important to develop are critical thinking skills, problem solving, metacognition, communication, collaboration, innovation and creation, ICT literacy, and various other skills (Wibowo et al., 2022). In the aspect of education, we are entering the era of education 4.0, where there are great challenges for the education workforce today. This has to do with not only preparing learners to master the skills they need, but how they are able to compete with technological machines, and preparing learners for a future that is completely different from before (Erfianti et al., 2019).

In fact, the thinking ability of Indonesian students is still low as a result of TIMSS (Trends in International Mathematics and Science Study) and PISA (Program for International Student Assessment), especially in the field of science (Rosidin et al., 2019). Various studies show that among the causes of students' low HOTS ability are because the educational approach used is not effective in promoting students' HOTS (Maryani et al., 2022), lack of basic knowledge and direct experience to solve daily problems in the learning process is also the cause of low efforts to provide education to achieve HOTS (Maryani et al., 2022). In addition, based on the results of Yuliati & Lestari's research, (2018) students still do not have good awareness or understanding in answering HOTS-oriented questions.

The demands of 21st-century science materials related to the development of HOTS owned by students are important goals because of the significant relationship between HOTS and student academic achievement, as stated by Ramos, et al., (2013); Fariyani et al., (2017); Tanujaya, et al., (2017); Gallagher et al., (2012). Students at the Elementary School (ES) level, students usually begin to be taught to identify problems and solve simple problems while Junior High School (SMP) students begin to be required to be able to identify rather complicated problems. For the Bachelor Program (BP) and Master Program (MP) levels, students must be able to solve complex problems (Ichsan et al., 2019). But analysis of HOTS's learning needs to generate ideas, according to Heong et al. (2012), is much more difficult.

How to Cite:
Jihannita, J., Prasetyo, Z.K., & Wilujeng, I. (2023). How to Prepare HOTS to Face the 21st Century?. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 486–492. https://doi.org/10.29303/jppipa.v9i8.2847

To develop HOTS, students must master factual, conceptual, and procedural aspects to be able to apply the knowledge they have and analyze each stage to find solutions (Hujjatusnaini et al., 2022). In this case, HOTS is needed to solve problems in the 21st century, create superior quality human resources, and prepare them to solve problems in the future (Sepriyanti et al., 2022).

There has been a lot of research done to develop HOTS students, due to the importance of these skills to face the 21st century. The focus of its development is mainly on learning which should put HOTS are even better. This is related to the different learning models that can be chosen to develop HOTS. Where the chosen learning model should lead to the goal of solving a problem, and provide innovation for the solution of a problem (Ichsan et al., 2022). The learning model must also continue to be applied by making modifications to the learning media used. In addition, the development of instruments that can measure students' HOTS abilities has also been widely carried out. The role of the teacher has become so complex and more vital in the 21st century. Teachers must be able to realize the characteristics of 21st century learners who emphasize 4C skills; critical thinking and problem solving, creativity and innovation, communication, and collaboration. Collins, (2014); Misir, (2018); Anon, (2015); also explains the importance of digital literacy consisting of information literacy, media literacy, and ICT literacy as a characteristic of 21st century learning.

A systematic study that discusses high-level thinking skills (HOTS) in Indonesia holistically and comprehensively has not been conducted. Therefore, this study aims to analyze the extent to which research that seeks HOTS in Indonesia is developed, especially in relation to facing the 21st century, today.

Method

This qualitative research uses a content analysis approach with a systematic literature review technicality, to analyze the development of HOTS research in Indonesia. Literature review is carried out to collect research findings and other information, as in basic or applied research, one of the purposes of a literature review is to determine the state of knowledge of concern. The research method used adopts the method of (Fauzy & Pradipta, 2018).

There are as many as seven main aspects that need to be reviewed for content analysis in this study. These aspects include: the number of publications per year; the type of research; the subject of the study; the topic selected for the study; treatment; data collection instruments; and data analysis methods (Fauzi & Pradipta, 2018). The articles that have been analyzed consist of 26 articles published in 2015-2022, which are sourced from national journals with a minimum indexed sinta 3, and an international minimum indexed DOAJ. The collected data are analyzed using percentage calculations.

Result and Discussion

HOTS Research Topics

The results of HOTS research from year to year are presented in raffle form below. In the period around 2015 to 2022, a lot of research related to HOTS was produced. Where the most research was conducted in 2022 (42%), 2019-2021 (15%), 2015 (8%), and 2018 (4%). Research related to HOTS was not produced at all in 2016 and 2017.

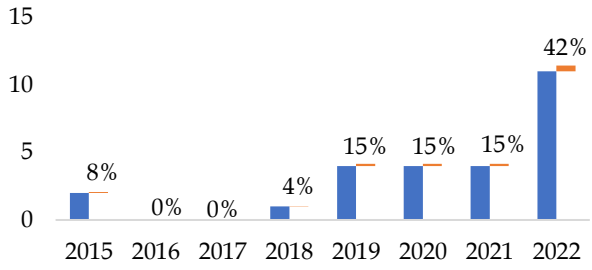

Figure 1. HOTS research from year to year

Table 1. Research Topics to improve HOTS

Topic	Frequency	Percentage (%)
Assessment instrument	13	50
Learning process	5	19
Learning media	4	15
Not mentioned	4	15

Based on Table 1, it is known that research topics are dominated by research related to assessment instruments (50%), learning processes (19%), learning media, and other topics that are not clearly mentioned in the study by (15%). Research related to this instrument has been widely developed to measure students' high-level thinking ability with the help of HOTS-based test items. The instrument developed, according to Maharani & Rakhmati, (2015) focuses on questions analyzing arguments, considering reliable information, analyzing observation reports, comparing and determining conclusions, considering induction abilities, assessing, defining concepts, defining assumptions, describing (Hidayatullah et al., 2022). Well-designed assessments can effectively enhance learning and this is still a low concern in the implementation of HOTS-based learning.

The learning process is also a research topic that has been developed a lot related to HOTS. Among the learning strategies and models that are widely used in

the results of the analysis of several existing articles are the challenge-based learning model, the STEM-PjBKL approach, the metacognition integrated learning model that prioritizes student independence and freedom, technology-based learning, the discovery learning model, and the problem-based learning model. This explains that efforts to improve the learning process and learning media that lead to the development of HOTS still need to be developed. This is consistent with the demands of 21st century learning that cannot be separated from innovative learning models, while also involving the process of assessing achievement competencies in learning. Some 21st century skills are also top priorities in today's learning outcomes. McNeill et al., (2012); Rustaman, (2004); Sambel et al., (2019), explained that measuring learning outcomes requires alternative learning models and learning assessment. In a test according to Darling-Hammond et al., (2010) the student should not be the subject of information collectors, but the student must be able to discover, evaluate, synthesize, use knowledge in new contexts, organize and solve unusual problems (Zulfiani et al., 2020).

Based on figure 2 related subjects in the HOTS research dominated by diverse (miscellaneous) subjects related to the environment, animal ecology, advanced science, and those that are not clearly defined as much as (38%), followed by subjects of science and physics (23%), biology (12%), and chemistry (4%). The variety of subjects developed based on HOTS skills according to Chetty, (2015); Snyder & Snyder, (2008); Ten Dam & Volman, (2004) indicates that higher-order thinking skills are believed to improve students' ability to prepare for the challenging and evolving era of the 21st century. The hope is that students will be better able to live in a social environment (Ramadhan et al., 2019).

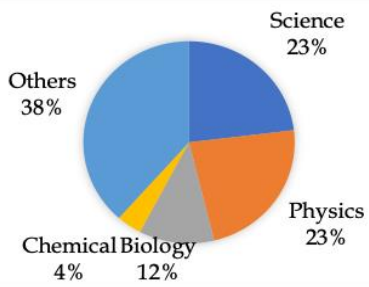

Figure 2. Subjects in HOTS research

Definition of HOTS

The concept of higher-order thinking skills is based on several opinions, as can be seen in Table 2.

Table 2. Basic Concepts of HOTS

Problem Solving Krulik & Rudnick (1998)	Bloom's Taxonomy Cognitive Domain (1956)	Bloom's Taxonomy Anderson & Krathwol Revision (2001)	HOTSCC Ichsan's Taxonomy (2021)
Recall	Knowledge	Remember	Criticize Problem
Basic	Comprehension	Understand	Solve Problem
Critical	Application	Apply	Develop Innovation
Creative	Analysis	Analyze	
	Synthesis	Evaluate	
	Evaluation	Create	

HOTS has distinctive features. The ability to think higher levels is the thought process of students in a higher cognitive level. In this case, it is explained that it begins with remembering information, connecting various information owned into a whole concept, to the achievement of critical and creative thinking. HOTS is related to key aspects of the investigation (Tanak, 2020). This level of high-level thinking ability includes students' abilities or skills in analyzing, evaluating, and creating. Indicators of analyzing, evaluating, and creating skills are based on the theory presented in bloom's revision by Anderson & Krathwol. Saputra, (2016) explains the main objective of higher-order thinking skills is how to improve students' thinking skills at a higher level, especially those related to the ability to think critically in receiving different types of information, thinking creatively in solving problems using knowledge and making decisions in complex situations (Gultom et al., 2021).

HOTS with Climate Change (HOTSCC) with Ihsan Taxonomy was developed as an emphasis on problem-solving capabilities related to environmental change. In this case, students as an important component in society are expected to be able to manage issues related to climate change as well as its impacts. The purpose of this taxonomy is to improve accuracy in HOTS measurements in relation to environmental education at all levels (Ichsan et al., 2022). Revisions made by changing the dimension of thinking skills from Anderson's taxonomy. Climate change was chosen as an environmental issue that requires study and problem solving. HOTSCC-Ihsan's taxonomy was developed to implement climate change into additional content/topics in the field of science of the entire group of knowledge. HOTS on Ichsan's taxonomy also led to an increased orientation to innovation, as a continuation of Anderson's creative skills.

Learning Processes that Lead to HOTS Progress

Learning as a process of changing one's behavior as a result of learning. These changes can be observed in behavioral and cognitive aspects (knowledge) (Ulfa et al., 2022). The expected changes from this learning process are expected to lead to competitive outputs and 21st century or HOTS-based skills. Students need HOTS skills to solve problems in everyday life that are logical and reflective (Afikah et al., 2023). HOTS contributes to equipping students to compete globally through critical, reflective, innovative thinking in solving real-life problems (Ichsan, Pertiwi, et al., 2022; Sidiq et al., 2021).

Learning using HOTS requires an intensive role of the teacher during the learning process. HOTS can be developed during a structured learning process through stages in what is called a learning model (Yerimadesi et al., 2023). Improving HOTS in learning can be pursued through the use of appropriate learning methods and assessment techniques to measure students' HOTS. Based on the results of the article analysis, several choices of learning processes that are proven to improve HOTS include using STEM (Rosidin et al., 2019). Science, Technology, Engineering, and Mathematics (STEM) highly values the ability to establish connections between basic concepts and generate new research questions (Carroll & Harris, 2020). Learning outcomes are more optimal because learning involves a high level of ability to categorize, compare, and distinguish ideas and theories, writing skills, and problem-solving skills. The integration of STEM has the potential to provide opportunities for students to practice HOTS through problems that must be solved (Agussuryani et al., 2022).

Several other learning models such as PBL, PjBL, and metacognition strategies are also choices that can maximize students' thinking skills in overcoming real-world problems (Maryani et al., 2022). PBL provides students with the opportunity to engage in the inquiry/inquiry process (Tâm, 2021). PBL makes students the center of problem solving that fosters students' independent ability to learn, and creates freedom to develop innovations as a solution to a problem (Gultom et al., 2021). The resulting solution can be a project that leads to the implementation of the PjBL model. This model is problem-oriented as the first step in collecting and integrating new knowledge based on experience and is designed to analyze solutions to complex problems in investigation (Hujjatusnaini et al., 2022). Students in solving problems must prioritize their independence in thinking while learning. Metacognition strategies allow for the creation of open solutions, thus preparing students to be active as problem solvers (Maryani et al., 2022). In the problem-solving process, students improve their scientific character to be persistent in learning, develop curiosity, and actively collaborate to discuss content with teachers and classmates (Almerich et al., 2020; Amin &; Ikhsan, 2021; Erfianti et al., 2019).

Based on the results of this literature research, it is known that several learning models to improve HOTS have the main characteristics of student-centered learning. The characteristics of student-centered learning are: learning occurs in small groups of students; the role of the teacher as a facilitator; affairs form an organizing focus and stimulus for learning; problems are a vehicle for the development of problem-solving skills; and new information acquired through self-study (p. 5–6) (deChambeau & Ramlo, 2017). The presentation of information during the learning process involves technological media. The selection of this technology media is to help students visualize abstract concepts. Learning to use mobile devices provides benefits for students and also helps teachers in learning. Existing interactive social media has also influenced the development of the learning environment, and the use of personal learning environments by teachers and students in general (Elfeky, 2019).

At the end of the learning process, a learning assessment is carried out, to measure student ability during—after the teaching and learning process. In conducting assessments students should not be the subject of information collection but should be able to find, evaluate, synthesize, use knowledge in new contexts, and organize and solve non-routine problems (Zulfiani et al., 2020). According to (Permendikbud) No. 53 of 2015, the assessment of study results by educators is the process of collecting information or data about student achievement in aspects of attitudes, aspects of knowledge, and aspects of skills carried out systematically to observe the process, study progress, and improvement of learning outcomes by providing assignments and evaluating study results (Dhewa Kusuma et al., 2017). Several assessment techniques that have emerged to measure HOTS such as Computer Adaptove Test (CAT), assessment for learning based on HOTS, (Khoiriah et al., 2020), reasoned multiple choice questions / Two Tier Multiple Choice (TTMC and instruments that can measure students' ability in higher-order thinking have been developed, but still need to be pursued. This is because assessment not only functions to measure students' thinking skills, but also must be in accordance with learning objectives, meaningful and contribute to student achievement (Ulfa et al., 2022).

The assessment carried out must also be appropriate, meaning that it can be used or lead to improved student learning. From the assessment carried out can also reveal areas of weakness and strengths of students. Areas of strength to be treated and areas of weakness should be improved (Abosalem, 2015). In the end, the assessment function becomes a reflection of the student. Based on Whalen & Paez's research, 2021),

students see reflection as a tool to develop and use cognitive and metacognitive skills, and also as a tool to favor knowledge retention and transfer. This contributes to the acquisition of higher-order thinking skills necessary to tackle the challenges of complex real-world problems.

Research Methods

The dominant research methods used to research HOTS are research and development (RnD) or research and development (31%), quantitative (27%), descriptive studies (12%), surveys (15%), case studies, mixed methods, classroom action research, and systematic reviews respectively (4%). The dominance of this research and development method has resulted in many assessment instruments to measure HOTS effectively. As for the type of RnD research used using several existing stages such as the Oreondo, Borg & Gall, 4D (define, design, develop, and disseminate), Dick & Carrey stages.

Table 3. HOTS Research Methods

Research methods	Frequency	Percentage (%)
RnD	8	31
Kuantitative	1	4
Quasi	4	15
Experimental	2	8
Kualitative		0
Descriptive Study	3	12
Survey	4	15
Case Study	1	4
Mix Method	1	4
CAR	1	4
Systematic review	1	4

Research Samples

Figure 3 shows the sample types in the HOTS study. It can be seen that the most widely used samples in this study were at the tertiary level (35%), at the junior high school level (31%), elementary and high school (15%). Furthermore, the sample size used in this study was the largest in the range of 50-100 samples (42%), samples that were not clearly stated in number (27%), samples in the range of 200-300 (15%), > 300 samples (12%), and about 30 samples (4%).

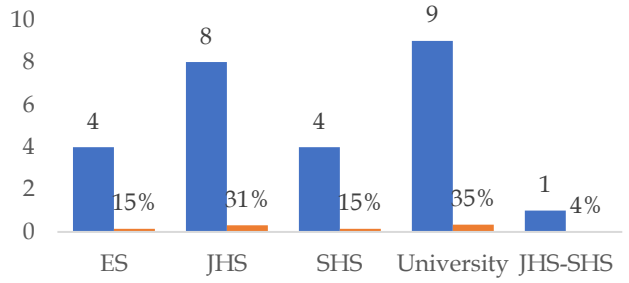

Figure 3. Sample Types in HOTS research

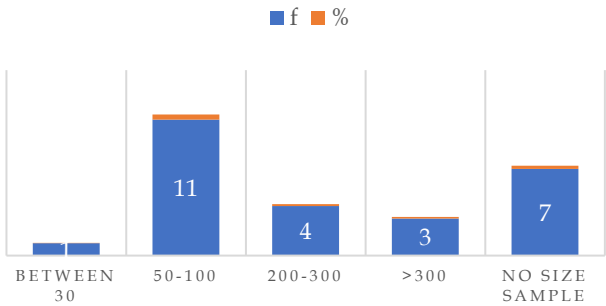

Figure 4. Sample Size in HOTS research

Analysis Methods

In this study, the data analysis methods used were very diverse. You can see the analysis methods used in table 4. With the most frequently used analysis methods are aiken V and inferential satatistic (15%), N-Gain analysis (11%), one-way anova (7%), and the rest with a percentage of each (4%).

Table 4. HOTS research analysis methods

Analysis Method	Frequency	Percentage (%)
Aiken V	4	15
Cronbach alpha	1	4
Paired sample t-test	1	4
Infit MSQ	1	4
Product moment correlation percentage	1	4
MANOVA	1	4
MicroCat Iteman	1	4
Statistik Inferensial	4	15
One Way Anova	2	7
N-Gain	3	11
One sample t-test	3	11
Mann Withney U test	1	4
Pearson correlation	1	4
Spearmen brown	1	4
Kruskal wallis	1	4
Levene test	1	4

Instrument Type

From Table 5, it can be seen that several instruments used in HOTS research, namely test instruments (45%), questionnaires (24%), multiple choice questions (11%), worksheets, interview sheets, observations, and documentation respectively (5%).

Table 5. Types of HOTS research instruments

Instrument Types	Frequency	Percentage (%)
Test instrument	17	45
Questionnaire	9	24
Worksheet	2	5
Multiple choice	4	11
Interview	2	5
Observation sheet	2	5
Documentation	2	5

Conclusion

Based on the results of data analysis, research on higher-order thinking skills (HOTS) in Indonesia is dominated by the development of instruments used to measure students' HOTS as well as the application of learning using innovative methods to improve HOTS. Scientific disciplines developed on the basis of higher-order thinking skills are also very diverse with students in universities as a sample that is often used. HOTS is defined as based on the notion of a problem-solving thinking framework, Bloom's cognitive domain and its revisions, and HOTS Climate Change which emphasizes the level of innovation development. Most sample sizes are in the range of 50-100 samples. The most commonly used research design is RnD research.

Acknowledgements
The author would like to express gratitude to Yogyakarta State University and all parties who support the publication of this article.

Authors Contribution
Zuhdan Kun Prasetyo, Insih Wilujeng: proofreading the content, conducting a comprehensive review.

Funding
LPDP scholarship.

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

References

Abosalem, Y. (2015). Assessment techniques and students' higher-order thinking skills. *ICSIT 2018 - 9th International Conference on Society and Information Technologies, Proceedings*, 61–66. https://doi.org/10.11648/j.ijsedu.20160401.11

Afikah, A., Rohaeti, E., Jumadi, J., & Perdana, R. (2023). Student's higher-order thinking skills and collaboration skills in online learning during pandemic. *International Journal of Evaluation and Research in Education*, *12*(1), 23–33. https://doi.org/10.11591/ijere.v12i1.23797

Agussuryani, Q., Sudarmin, S., Sumarni, W., Cahyono, E., & Ellianawati, E. (2022). STEM literacy in growing vocational school student HOTS in science learning: A meta-analysis. *International Journal of Evaluation and Research in Education*, *11*(1), 51–60. https://doi.org/10.11591/ijere.v11i1.21647

Almerich, G., Suárez-Rodríguez, J., Díaz-García, I., & Cebrián-Cifuentes, S. (2020). 21st-century competences: The relation of ICT competences with higher-order thinking capacities and teamwork competences in university students. *Journal of Computer Assisted Learning*, *36*(4), 468–479. https://doi.org/10.1111/jcal.12413

Amin, D. I., & Ikhsan, J. (2021). Improving higher order thinking skills via semi second life. *European Journal of Educational Research*, *10*(1), 261–274. https://doi.org/10.12973/EU-JER.10.1.261

Carroll, K. A., & Harris, C. M. (2020). Using a Repetitive Instructional Intervention to Improve Students' Higher-Order Thinking Skills. *College Teaching*, *69*(2), 82–90. https://doi.org/10.1080/87567555.2020.1823310

deChambeau, A. L., & Ramlo, S. E. (2017). Stem high school teachers' views of implementing PBL: An investigation using anecdote circles. *Interdisciplinary Journal of Problem-Based Learning*, *11*(1). https://doi.org/10.7771/1541-5015.1566

Dhewa Kusuma, M., Rosidin, U., & Suyatna, A. (2017). The Development of Higher Order Thinking Skill (Hots) Instrument Assessment In Physics Study. *IOSR-JRME*, *7*(1), 2320–2737. https://doi.org/10.9790/7388-070103XXXX

Elfeky, A. I. M. (2019). The effect of personal learning environments on participants' higher order thinking skills and satisfaction. *Innovations in Education and Teaching International*, *56*(4), 505–516. https://doi.org/10.1080/14703297.2018.1534601

Erfianti, L., Istiyono, E., & Kuswanto, H. (2019). Developing lup instrument test to measure higher order thinking skills (HOTS) Bloomian for senior high school students. *International Journal of Educational Research Review,* *4*(3), 320-329. https://doi.org/10.24331/ijere.573863

Fauzi, A., & Pradipta, I. W. (2018). Research methods and data analysis techniques in education articles published by Indonesian biology educational journals. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *4*(2), 123–134. https://doi.org/10.22219/jpbi.v4i2.5889

Gultom, S. T., Siahaan, P., & Suhandi, A. (2021a). Effect of PBL Hybrid Learning on the Higher Order Thinking Skills of Seventh Grade Students in Global Warming and Their Environmental Care Attitudes. *Jurnal Penelitian Pendidikan IPA*, *7*(SpecialIssue), 272–280. https://doi.org/10.29303/jppipa.v7ispecialissue.1012

Hidayatullah, A. R., Yamtinah, S., & Masykuri, M. (2022). Development of A Two-Tier Multiple-Choice Instrument Based on Higher Order Thinking Skills (HOTS) on Acids, Bases, and Salts. *Jurnal Penelitian Pendidikan IPA*, *8*(2), 932–938. https://doi.org/10.29303/jppipa.v8i2.1423

Hujjatusnaini, N., Corebima, A. D., Prawiro, S. R., & Gofur, A. (2022b). The Effect Of Blended Project-

Based Learning Integrated With 21st-Century Skills On Pre-Service Biology Teachers' Higher-Order Thinking Skills. *Jurnal Pendidikan IPA Indonesia*, *11*(1), 104–118. https://doi.org/10.15294/jpii.v11i1.27148

Ichsan, I. Z., Pertiwi, S., & Hermawan, Y. (2022). HOTS about Environment and Designing Science Serial Books for Digital Learning in Elementary School. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 2378–2383. https://doi.org/10.29303/jppipa.v8i4.2153

Ichsan, I. Z., Sigit, D. V., Miarsyah, M., Ali, A., Arif, W. P., & Prayitno, T. A. (2019). HOTS-AEP: Higher order thinking skills from elementary to master students in environmental learning. *European Journal of Educational Research*, *8*(4), 935–942. https://doi.org/10.12973/eu-jer.8.4.935

Khoiriah, K., Jalmo, T., & Abdurrahman, A. (2020). Implementasi assessment for learning berbasis higher order thinking skills untuk menumbuhkan minat baca. *Jurnal Inovasi Pendidikan IPA*, *6*(2). https://doi.org/10.21831/jipi.v6i2.22817

Maryani, I., Prasetyo, Z. K., Wilujeng, I., & Purwanti, S. (2022). Promoting higher-order thinking skills during online learning: The integration of metacognition in science for higher education. *International Journal of Evaluation and Research in Education*, *11*(4), 1980–1988. https://doi.org/10.11591/ijere.v11i4.23129

Ramadhan, S., Mardapi, D., Prasetyo, Z. K., & Utomo, H. B. (2019). The development of an instrument to measure the higher order thinking skill in physics. *European Journal of Educational Research*, *8*(3), 743–751. https://doi.org/10.12973/eu-jer.8.3.743

Rosidin, U., Suyatna, A., & Abdurrahman, A. (2019). A combined HOTS-based assessment/STEM learning model to improve secondary students' thinking skills: A development and evaluation study. *Journal for the Education of Gifted Young Scientists*, *7*(3), 435–448. https://doi.org/10.17478/jegys.518464

Sepriyanti, N., Nelwati, S., Kustati, M., & Afriadi, J. (2022). The Effect Of 21st-Century Learning On Higher-Order Thinking Skills (Hots) And Numerical Literacy Of Science Students In Indonesia Based On Gender. *Jurnal Pendidikan IPA Indonesia*, *11*(2), 314–321. https://doi.org/10.15294/jpii.v11i2.36384

Sidiq, Y., Ishartono, N., Desstya, A., Prayitno, H. J., Anif, S., & Hidayat, M. L. (2021). Improving elementary school students' critical thinking skill in science through hots-based science questions: A quasi-experimental study. *Jurnal Pendidikan IPA Indonesia*, *10*(3), 378–386. https://doi.org/10.15294/JPII.V10I3.30891

Tâm, N. T. M. (2021). Using Problem-based Tasks to Promote Higher-order Thinking Skills for TESOL MA Students in Vietnam. *Interdisciplinary Journal of Problem-Based Learning*, *15*(1). https://doi.org/10.14434/ijpbl.v15i1.28772

Tanak, A. (2020). Developing Pre-service Science Teachers' Teaching Practices with an Emphasis on Higher Order Thinking. *Science Education International*, *31*(3), 237–246. https://doi.org/10.33828/sei.v31.i3.2

Ulfa, M., Ulfa Tenri Pada, A., & Rahmatan, H. (2022). The Development of Higher Order Thinking Skills (Hots) Test Instrument on Metabolism Topic For Senior High School Level. In *IJAEDU-International E-Journal of Advances in Education, 8*(23), 118-126. https://doi.org/10.18768/ijaedu.1140976

Whalen, K., & Paez, A. (2021). Student perceptions of reflection and the acquisition of higher-order thinking skills in a university sustainability course. *Journal of Geography in Higher Education*, *45*(1), 108–127. https://doi.org/10.1080/03098265.2020.1804843

Wibowo, W. S., Wasana, M. A., & Muhammad, F. N. (2022). Peningkatan Higher Order Thinking Skills Peserta didik Melalui Pembelajaran IPA Berbasis Discovery Learning Berbantuan E-LKPD pada Materi Usaha dan Pesawat Sederhana. *Jurnal Inovasi Pendidikan IPA*, *8*(1). https://doi.org/10.21831/jipi.v8i1.45860

Yerimadesi, Y., Warlinda, Y. A., Rosanna, D. L., Sakinah, M., Putri, E. J., Guspatni, G., & Andromeda, A. (2023). Guided Discovery Learning-Based Chemistry E-Module and Its Effect on Students' Higher-Order Thinking Skills. *Jurnal Pendidikan IPA Indonesia*, *12*(1). https://doi.org/10.15294/jpii.v12i1.42130

Yuliati, S. R., & Lestari, I. (2018). Higher-Order Thinking Skills (Hots) Analysis Of Students In Solving Hots Question In Higher Education. *Perspektif Ilmu Pendidikan*, *32*(2), 181–188. https://doi.org/10.21009/pip.322.10

Zulfiani, Suwarna, I. P., & Sumantri, M. F. (2020). Science adaptive assessment tool: Kolb's learning style profile and student's higher order thinking skill level. *Jurnal Pendidikan IPA Indonesia*, *9*(2), 194–207. https://doi.org/10.15294/jpii.v9i2.23840