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Online Learning with Project Based Learning Model to Increase Student HOTS in Waves and Optical Courses

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Abstract: Higher Order Thinking Skills (HOTS) is one of the competencies that must be trained from early childhood to university so that students can compete globally. The facts show that the competence of students in Indonesia is still classified at the LOTS level. Therefore, various efforts are needed to improve the competence of students so that the level of competency they have can increase. This research aims to increase student HOTS in Waves and Optics courses through online lectures using the Project Based Learning (PjBL) model. This research was conducted in 5 meetings, from April 19 2022 to May 31 2022. The research subjects consisted of 27 students who took Waves and Optics lectures in Class IV-B, in the Physics Education Study Program, University of Mataram, Academic Year 2021/2022. The research instrument for obtaining HOTS score data is an essay test given at the beginning of the meeting and at the end of the meeting. The increase in HOTS scores is calculated using the N-gain test. The results showed that the average HOTS score of students in the initial test was 55, while in the final test it was 79. The N-gain score was 54 which is included in the medium category. Thus, it can be concluded that online lectures using the Project Based Learning model in the Waves and Optics course increase the HOTS scores of prospective physics teacher students.

Keywords: HOTS, Online, Project Based Learning.

INTRODUCTION

The ability to think scientifically possessed by students in Indonesia is still relatively low. This information is based on a survey conducted by international institutions, namely PISA and TIMMS. One of the reasons for the low ability to think scientifically is that students are still not trained enough to solve HOTS questions. Assessment instruments designed to train HOTS are low or not yet available. Therefore, it is necessary to develop a HOTS-based assessment instrument with indicators including: ability to perform analysis or C4 level, ability to evaluate or C5 level, and ability to create or C6 level (Kusuma, Rosidin and Suyatna, 2017).

Planning, implementing, and evaluating learning that focuses on increasing student HOTS is important for optimizing learning processes and outcomes (Abdullah *et al.*, 2015). HOTS or higher-order thinking skills are skills that must be applied to all subjects, including physics in high school or college, as well as science subjects in early childhood, elementary and junior high schools. Therefore, teachers and even prospective teachers are required to be skilled in designing, implementing, and evaluating HOTS-based learning so that students can master the competence or ability to think scientifically (Sulaiman *et al.*, 2017).

The HOTS category of students who are still at a low level requires various efforts and attention from all parties. Increasing HOTS scores can be obtained through efforts including developing learning media, learning materials, and innovative learning models (Ichsan *et al.*, 2019). One of the innovative learning models that can improve students' HOTS is the Project Based Learning (PjBL) model. The application of the PjBL model can stimulate students' creativity to generate various ideas in making certain innovative products. This creativity is part of the student's HOTS which needs to be continuously trained or developed through various project-based activities (Zakiah, Fatimah and Sunaryo, 2020).

The ability of students to analyze, compare, and evaluate is a HOTS which has an influence on the performance of students in the physics learning process (Ramos *et al.*,

2013). Student teacher candidates must have HOTS so that later they can train their students to have HOTS as well through various learning activities when they teach in real classes (Yuliati and Lestari, 2018). Efforts to increase student HOTS through lectures with the PjBL model are not only limited to face-to-face learning in class, but also through online learning, especially during the pandemic which limited meetings or interaction between lecturers and students directly in class.

The existence of the COVID-19 pandemic has caused a change in the learning system in Indonesia, from face-to-face learning to online learning. Students argue that online learning is no more interesting than face-to-face learning even though some students can understand the learning material and students are facilitated by the teacher in participating actively during the learning process (Mulyanti, Purnama and Pawinanto, 2020). The COVID-19 pandemic has forced the government to issue policies on limiting direct social interaction so that learning in the classroom experiences restrictions and even requires students to study from home (Zuhairoh and Rosadi, 2020). Learning in the 21st century and the COVID-19 pandemic poses challenges in the world of education, especially in online learning systems that require users to utilize information and communication technology or ICT (Zai *et al.*, 2020).

Online learning in a distance learning system can be carried out through two patterns, namely: first, an asynchronous pattern in the form of an LMS (Learning Management System); second, sync patterns through video conferencing technology such as Zoom Cloud Meeting, Microsoft Teams, or Google Meet (Camilleri and Camilleri, 2021). Online learning through LMS can also be modified with other applications such as WhatsApp to facilitate coordination. Online learning can improve students' cognitive abilities from level C1 to C6 (Anugrahana, 2021). Online learning content through the LMS application can be made systematic (structured) so that it makes it easier for students to study independently. Various interesting features can facilitate students in mastering various knowledge and skills (Wati, Siahaan and Wiyono, 2021).

The online lecture system requires adequate facilities and infrastructure so that both lecturers and students can access the internet without network constraints (Yusuf *et al.*, 2021). Online lectures at universities are used as part of efforts to overcome the COVID-19 outbreak or pandemic. Online lectures using LMS are conducted globally in countries such as the US, UK, Canada and Australia, including universities in Saudi Arabia. (Aldiab *et al.*, 2019). Lectures using ICT in the form of LMS applications are also used in Indonesia. Online learning with Project based learning is an innovative method that can be developed to improve HOTS in the era of the industrial revolution 4.0. Through communication and collaboration as students work on producing projects, students can reduce mistakes and make changes for the better (Eliyasni, Kenedi and Sayer, 2019).

Implementation of online lectures with the PjBL model to improve student HOTS needs to consider various things such as the availability of facilities and infrastructure for smooth internet access, including consideration of student characteristics and the characteristics of lecture materials. Based on the analysis of the results of the midterm exams in the Waves and Optics courses, information was obtained that students' abilities in analyzing, evaluating, and creating still needed to be improved. This study aims to increase student HOTS in the Waves and Optics courses through online lectures with the Project Based Learning (PjBL) model.

METHODS

This research was conducted in 5 meetings, from 19 April 2022 to 31 May 2022. The learning materials are shown in Table 1.

Table 1. Learning Materials

Meeting/Date	Learning materials
1/19 April 2022	Wave
2/26 April 2022	Fourier's rule
3/10 May 2022	Electromagnetic Waves
4/17 May 2022	Eyes, Camera, Lens
5/31 May 2022	Microscopes, Binoculars, Scanners

The research subjects consisted of 27 students who took Waves and Optics courses in Class IV-B, in the Physics Education Study Program, University of Mataram, Academic Year 2021/2022. Online lecture activities using the Project Based Learning (PjBL) model follow the steps: first, determine fundamental questions; second, designing project planning; third, to arrange the schedule; fourth, monitoring students and their project progress; fifth, test the results;

sixth, evaluate the experience (Winangun, 2021). Online lectures with Project Based Learning to improve student HOTS in the Waves and Optics courses are carried out through the Learning Management System (LMS). The LMS referred to in this study is the University of Mataram Online Learning System (SPADA) which can be accessed via the following link: https://daring.unram.ac.id/

The product produced from lectures through the PjBL model in research is PowerPoint (PPT). Lecturers give textbooks of Waves and Optics to students. Students are assigned to make PPT based on the material contained in the textbook. The PPT contains a summary of the material, derivation of equations, and illustrations in the form of photos and simulation video links to clarify the description of the material, as well as practice questions accompanied by answers that are scanned and attached in the PPT.

Lecturers facilitate student discussions through SPADA Mataram University, namely on the "Group Discussion Forum" menu. The lecturer divides the students into study groups, each group will ask questions related to the topics discussed in one meeting, and the PPT presenters will be given responses/answers. Lecturers will also provide feedback through the comments column. The coordination of the implementation of online lectures utilizes the WA Group so that the use of time is also more effective. Preliminary activities, coordination of core activities, and closing activities are carried out through WAG.

The research instrument for obtaining student HOTS score data is an essay test given at the beginning of the meeting and at the end of the meeting. Degrees of mastery and categories of student scores are expressed in the letters shown in Table 2.

Table 2. Degree of mastery and value category

Degree of Mastery	Value Category
80 – 100	A
72 – 79	B+
65 – 71	B
60 – 64	C+
56 – 59	C
50 – 55	D+
46 – 49	D
0 – 45	E

The increase in student HOTS scores from the pre-test to the final test is calculated using the N-gain with the following equation (Hake, 1999).

$$N - gain = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} x100\%$$

The N-gain acquisition category is shown in Table 3.

Table 3. Category of N-gain acquisition

No	Interval (%)	Category
1	g > 70	High
2	30 ≤ g ≤ 70	Medium
3	g < 30	Low

FINDINGS AND DISCUSSION

The use of LMS in the Online Learning System (SPADA) can facilitate students mastering various competencies through various scientific activities. LMS provides a variety of interesting features that increase student motivation and interest in learning (Saputro and Susilowati, 2019). The online lectures conducted in this study are shown in Figure 1.

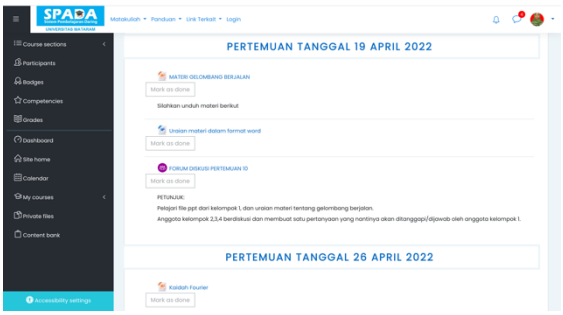

Figure 1. Online lectures

Various features utilized in SPADA are file features to make it easier for students to download learning materials, discussion forum features to facilitate interaction between lecturers and students and students with other students so that they can communicate, collaborate, and discover new concepts. Interactive online learning makes students happy about learning. They can access whenever and wherever they are. Lecturers can control the competency development of each student through the online learning system (Widyaningsih *et al.*, 2020).

The activity in the Discussion Forum feature is shown in Figure 2. The lecturer divides the topics according to the projects assigned to students according to their groups. The product in the form of a PowerPoint (PPT) file for each group will be responded to by the discussion pair group by asking various questions. Group members who own the product will provide responses or answers to

questions from discussion partner group members. The lecturer will provide the necessary comments to clarify the mastery of the concept being studied.

Figure 2. Group discussion topics

The form of responses or answers from representatives of the presenting group (who have PPT products) can be in the form of material descriptions, illustrated pictures, even video simulations to make it easier for students to understand concepts. The discussion process for each topic can be seen in Figure 3.

Figure 3. Group discussion process

The average HOTS score of students at the time of the initial test was 55 which was included in the D+ value category. There were 11 students who received C+ grades, 3 C grades, 9 D+ grades, and 4 E grades. The student HOTS scores generated in the pre-test administration are shown in Figure 4.

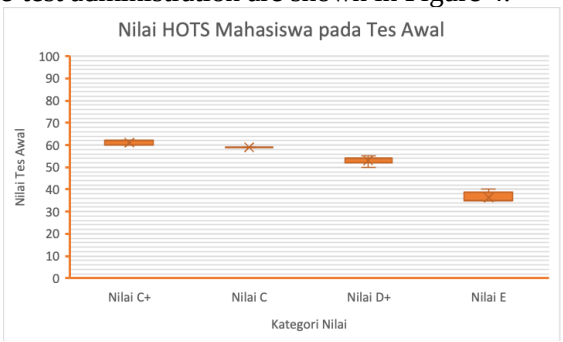

Figure 4. Student HOTS scores on the initial test

The average HOTS score of students at the time of the final test was 79 which was included in the category of B+ scores. The number of students who received an A score was 13 people, 10 people got a B+ score, and 4 people got a B grade. The student HOTS scores generated in the administration of the final test are shown in Figure 5.

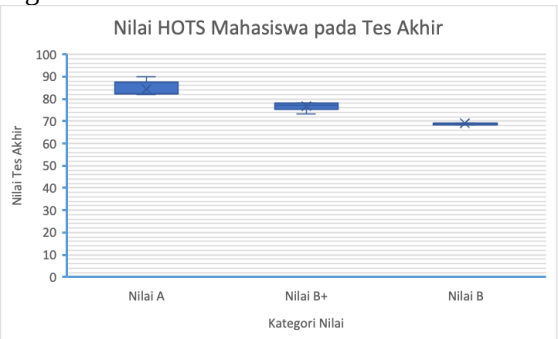

Figure 5. Student HOTS scores on the final test

The N-gain value obtained is 54 which is included in the medium category. This means that there is an increase in students' HOTS scores due to online lectures with the Project Based Learning model in the Waves and Optics courses. The number of students who have N-gain scores in the high category are 3 people, and 24 students in the medium category. The value and category of N-gain can be seen in Figure 6.

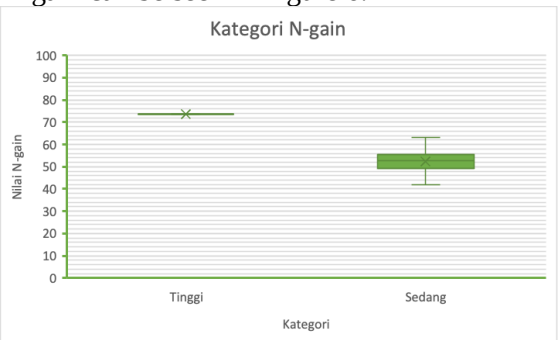

Figure 6. The N-gain category

Online learning through LMS needs to be developed especially during the COVID-19 pandemic. Online learning with LMS can be used as an interactive medium that helps teachers facilitate students learning from home when the number of face-to-face meetings is still lacking, and there are restrictions on the number of people and the existence of social distancing rules as an effort to stop the spread of the virus (Yetti and Ahyanuardi, 2020). The application of online learning can be done in stages according to the learning model used. Innovative learning models such as the PjBL model can be used as an alternative in implementing online lectures because they have various advantages.

The advantage that can be obtained through the application of the Project Based

Learning model is that it can improve students' critical thinking skills, communication skills, and collaboration which are very necessary to help them solve various life problems in the future (Nurjanah, Cahyana and Nurjanah, 2021). Learning by applying the PjBL model can train students' independent character (Ariyanto, Sutama and Markhamah, 2022).

Innovation to produce projects or products/work in online learning with the PjBL model can increase student creativity (Sadikin and Yelianti, 2021). Aspects of the skills students need in innovating to produce a work can be in the form of three things: first, the ability to think critically and solve problems; second, the ability to communicate and collaborate; third, creativity and innovation (Ayu, 2019).

Online learning, which has started to be used significantly since the COVID-19 pandemic, can not only improve student competence in the HOTS field, but also in the field of digital literacy, which is very much needed in an all-digital era (Dewi and Fatkhiyani, 2021). The use of LMS in online learning is effective in supporting learning process activities and improving student learning outcomes (Wati, Siahaan and Wiyono, 2022). The interaction between teachers and students in online learning using LMS went well. Students can download materials and have plenty of time for self-study (Muhardi *et al.*, 2020). Online learning can not only be done for the purpose of understanding concepts, but also for developing skills through practicum (Winangun, 2021).

Isolasi sosial akibat pandemi COVID-19 telah mengubah perilaku masyarakat di semua aspek kehidupan, termasuk dalam aspek pendidikan. Pembelajaran daring dilaksanakan Social isolation due to the COVID-19 pandemic has changed people's behavior in all aspects of life, including the education aspect. Online learning is carried out starting from the lowest level of education or early childhood education to the highest level or university (Raza *et al.*, 2021). Learning with the PjBL model to increase HOTS can be integrated with various phenomena that are close to everyday phenomena or experiences.

Increasing creativity as part of HOTS can also be pursued through the application of learning in the context of local wisdom. The product of the project assignments produced by students becomes more contextual. Learning will be more meaningful because it utilizes things or phenomena that are close to what students see or experience in everyday life (Almuharomah, Mayasari and Kurniadi, 2019). Learning that utilizes ICT with phenomena around students or ethno-science contexts can be an alternative in increasing student HOTS (Widyawati and Sujatmika, 2020). In this case, training for teachers in designing learning using the PjBL model needs to be carried out in accordance with the latest curriculum, namely the Freedom to Learn Curriculum. Training will be useful for teachers in increasing motivation and increasing their knowledge (Nugrohadi and Anwar, 2022).

CONCLUSION

Students' initial abilities in analyzing, evaluating, and creating are still in the low category, namely the value of D+. The final ability of students after treatment in the form of online lectures using the Project Based Learning model in the Waves and Optics course increased to a B+ grade. The increase in student HOTS scores from the N-gain calculation is in the medium category. In other words, online lectures using the Project Based Learning model in the Waves and Optics course have increased the HOTS scores of prospective physics teacher students.

Online lectures with the Project Based Learning model can be an alternative to the lecture system during the COVID-19 pandemic. The selection of online lectures with the PjBL model needs to consider the availability of facilities and infrastructure, especially those related to internet access. In addition, the determination of the PjBL model needs to pay attention to the characteristics of students and learning materials.

Researchers or education observers can develop online lectures with PjBL models based on local wisdom, including ethnoscience contexts so that learning becomes more meaningful. Students' motivation in learning is expected to be better when discussing material in the context of ethnoscience which can be in the form of various phenomena in everyday life.

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