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Analysis of High Level Thinking Skills, Character and Skills of Science Process of High School Students in Project Based Learning

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Abstract

This study aims to analyze higher order thinking skills, character, and science process skills of high school students on plant tissue material through the Project Based Learning (PPA) model. This research method uses Pre-Experimental Designs. This research was conducted in Muhammadiyah 1 Karanganyar high school. The research sample used was 78 students. The instruments used were multiple choice questions and observation sheets. Student learning outcomes data were analyzed using the N-Gain technique and the minimal classical completeness test to determine higher order thinking skills (HOTS). The results showed that the Project Besed Learning (PjBL) Model was effective in improving students' high-order thinking skills (HOTS) with an average N-Gain of 0.52 in the "medium" category. Effectively growing student character with an average score percentage of 70.36% is included in the "good" category. The character of students that grows includes disciplinary responsibility and cooperation. And it is effective in growing students' science process skills with an average score of 74.73% of science process skills in the "good" category, the science process skills that grow are observing, planning experiments, carrying out experiments, and communicating.

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INTRODUCTION

In this globalization era, Indonesian education is faced with various challenges and opportunities. According to Wijaya et al. (2016), students must have key competencies to be able to take part in real life in the 21st century . Through the Ministry of National Education, the Government has one of the main programs to improve the quality of education processes and outputs at the primary and secondary education levels , namely the development of character education, HOTS skills and abilities in students. Curriculum 2013 revised 2017 curriculum changes are focused on improving the linkage between core competencies (KI) and basic competencies (KD). As well as the need to me appear not you four kinds of things: Strengthening the Character Education (PPK); Literacy in the context of the school literacy movement; 4C (Creative, Critical thinking, Communicative, and Collaborative); and Higher Order Thinking Skill (HOTS) so that teachers need creativity in designing it (Wulandari & Mardiyah , 2018).

In biology learning, gaps were found in assessment techniques. The assessment process that has been carried out is only able to reveal in one area only, which should be able to develop the competence of attitudes, knowledge and skills (Sari et al. , 2015; Sadia, 2013). Many students still do not get 21st century skills when carrying out learning in schools due to transferring knowledge from teachers to students through the lecture method and dominating learning so that teacher-centered learning (Mayangsari et al. , 2016).

The next challenge is to develop *higher order of thinking* (HOT) in science learning. In fact, learning is still oriented towards developing and testing memory, thinking abilities of learners so that learners are reduced and simply understood as the ability to remember , (Yen & Halili, 2015; Yani, 2016). Students are required to have character qualities that are in accordance with the demands of 21st century skills, so efforts are made to strengthen character education (Kemendiknas, 2011).

Then students are also required to have science process skills to use scientific methods in developing science and acquire new knowledge or develop existing knowledge and involve intellectual, manual and social skills (Dahar, 2011). These three aspects that are owned by students will be facilitated to develop when students take an active role in the learning process. These roles include being a discussion participant, experimenter, presenter of discussion and experiment results, project implementer, and others.

In the 2013 Curriculum, biology learning activities use a scientific approach (scientific approch), although in fact it's not new. This scientific approach emphasizes the activeness of students in learning, and provides opportunities for students to build concepts in their knowledge independently, familiarize students with formulating, dealing with, and solving problems found (Marjan, 2014). This approach is able to improve the HOTS character, skills and abilities of students in learning, because it directly involves students in multiplying and finding concepts based on facts found individually or in groups.

Learning models that can train 21st century skills must have criteria that are student-centered, teamwork, and learning related to the context of everyday life so that problems encountered in everyday life can be used as learning topics. One learning model that meets these criteria is the *problem-based learning* (PPA) learning model (Mayasari *et al*, 2016). The existence of Project Based Learning learning on plant tissue material, students can do project-based practicum and can make preparations and observe directly.

The purpose of this study was to analyze the ability of high school students in higher order thinking (HOTS), character, and science processes of high school students in biology learning through the Project Based Learning (PJBL) model.

METHODS

This study uses the *Pre-Experimental Designs* method with the research design of *One-Shot Case Study.* This study m enggunakan two classes with the same treatment and starting capabilities similar assumptions. The results were observed by being given a *post test for* each class at the end of the lesson. The sample used in the study was two classes for the experiment with a total of 78 students. The data collected were in the form of students' higher order thinking skills (HOTS), student character and student science process skills. The research data were obtained from multiple choice questions with HOTS question type and observations on the character and science process skills of students during the PjBL learning process. Types of data, data collection techniques, instruments and data analysis techniques can be seen in table 1.

Table 1. Types of Data, Data Collection Techniques, Instruments, Data Analysis Techniques.

Type of Data	Data Collection Techniques	Instrument	Data analysis technique
Students' higher order thinking skills (HOTS)	Test	Multiple choice questions	N-Gain Minimal Classical Completeness Test
Student character	Observation	Observation sheet	Descriptive Percentage
Science process skills	Observation	Observation sheet	Descriptive Percentage

RESULTS AND DISCUSSION

The data in this study were in the form of students' ability in high-order thinking (HOTS), character, and science process skills of class 11 students as many as two classes on learning plant networks at Muhammadiyah 1 Karanganyar high school for the 2019/2020 academic year. Assessment of science process skills (psychomotor) and character development (affective) is carried out by direct observation during the learning process. And for HOTS (cognitive), it was done by pretest and posttest covering plant tissue material. Submaterials include identifying types of tissue in plants, explaining totipotential properties and tissue culture and analyzing the structure and function of tissues in plants.

High Order Thinking Skills (HOTS) of High School Students

Students' high order thinking skills (HOTS) were carried out using HOTS questions about plant tissue during the *pre-test* and *post-test* with the Minimum Completion Criteria (KKM) ≥ 75. The number of questions tested was 20 multiple choice questions. The results of the *pre test* and *post test are* presented in Table 2

Table 2. Results of High Order Thinking Skills (HOTS)

Data	Nilai	N-Gain	Criteria
Pre test mean score	42.76		
Post test mean score	73.08	0.52	Moderat
The number of students	78 students		
Students complete	62 students		
Students are not finished	18 students		
Lowest pre test score	15		
Highest pre test score	65		
Lowest post test score	25		
Highest post test score	90		

Based on Table 2 , information can be obtained that the overall average value has increased, it can be seen in the results of the N-Gain calculation, namely 0.52 with moderate criteria. This shows that the PjBL model is effective in improving the knowledge aspect. In this study, the *pre-test was* carried out before the learning activities were carried out to determine the extent to which students understood the material to be studied using the PjBL model. The results of the students' *pre-tests* showed that all students had not reached the specified KKM, meaning that none of the students had completed the initial test before learning with an average pre-test score of 42.76. And the *post test is* carried out after the learning activity uses the PjBL model. The *post test* results showed an increase in learning outcomes, as many as 62 students who completed the total number of students as many as 78 students. This shows that the PjBL model is able to provide an effect in the form of increasing student knowledge outcomes .

Higher order thinking skills (HOTS) are needed by students to increase students' creativity in science, such as synthesis and evaluation skills (Saido, 2015). Improving student learning outcomes is not only from seeing or reading theory, but also by carrying out applied learning activities so that students can relate their knowledge contextually, like working on a project on the PjBL model. Thus students can know directly the plant tissue and can distinguish parts of plant tissue.

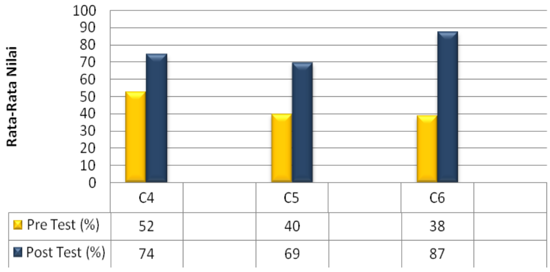

Figure 1. Increase in Value Viewed from the HOTS Point of View.

The questions made included high-order thinking skills (HOTS) and science process skills (KPS) in accordance with contextual learning on plant tissue material and the questions presented in the test emphasized the application questions. At high level thinking skills (HOTS) , the questions are used at level 3 (reasoning level), including the dimensions of the thinking process to analyze (C4), evaluate (C5), and create (C6) (Kemendikbud $_b$, 2017). Each dimension at the level of reasoning has increased before and after learning (Figure 1). The analyzing dimension (C4) has the highest percentage, namely 77% in the "very good" category. Problem type C4 demands the ability of students to specify aspects / elements, describe, organize, compare, and find implied meanings. Meanwhile, the types of questions C5 and C6 had a similar percentage, namely 68% and 65% in the "good" category. In the C5 type question (evaluating), it requires the ability of students to formulate hypotheses, criticize, predict, assess, test, justify or blame. And about type C6 (creating), demands the ability of student participants to design, build, plan, produce, discover, renew, perfect, strengthen, beautify, compose. HOTS questions at the reasoning level are not always difficult questions.

Problems with the HOTS type are characterized as containing interesting stimuli to encourage students to read, contextual stimuli such as pictures / graphics, text, visualization and others according to the real world, and on questions measuring cognitive aspects of reasoning such as analyzing, evaluating and creating / creating) .

This is in accordance with the research conducted by Sambite et al. (2019) state that learning using the PjBL model shows the percentage of classical completeness in cycle 2 has reached the research target. Students have started to get used to working on HOTS questions which consist of questions in the realm of analyzing (C4), evaluating (C5) and creating (C6) seen from the increase in the average score in the HOTS domain. This project based learning can improve students' higher order thinking skills (Rahayu, *et al.,* 2017; Fitri, et al., 2018 ; Eliyasni et al. , 2019; & Takiddin, et al., 2020).

The increase in higher order thinking skills in students during the learning process through the project based learning (PjBL) model, occurs when students are actively able to understand factual, conceptual, and procedural knowledge of application and connect new information with information already stored in their memory and combine knowledge and developing information obtained to achieve goals or find solutions to situations that are difficult to solve with their experience (Deluca, 2011; Anderson & Krathwohl, 2015; & Kurniati, et al., 2016). Teacher guidance contributes to this during the learning process by preparing a series of well-planned and well-planned activities (Zerihun et al. 2012).

High School Student Character

The results of observations on student character obtained during learning activities, from project planning, project implementation, product manufacturing, to product presentation. The results of the character of high school students can be presented in Table 3.

Table 3. High School Student Character

Value of each Character		
Character	Score (%)	Category
Responsible	67.77	B
Discipline	76.44	SB
Cooperation	66.88	B
Average	70.36	B

In the character (affective) aspect, it is assessed through observation during the learning process, based on project implementation and product creation, in accordance with the PjBL model. The characters observed include responsibility, discipline and cooperation, each indicator is adjusted to the activities to be carried out, such as during discussions, practicum and presentations. When conducting observations, it was found that the average percentage of student character results was 70.36% in the "good" category (Table 3). The highest discipline character among other characters is in the "very good" category with a percentage of 76.44%. Discipline indicators include, 1) orderly carrying out project activities according to the schedule made; 2) collect products / reports on time; 3) following project / experimental steps; 4) return the project / experimental equipment to its original place . The highest indicators are 3 and 4, because at the time of observation students follow the experimental steps in accordance with the experimental planning and teacher guidance, and students return practical equipment such as microscopes and others after completing experiments in the school laboratory. The lowest indicator is 2, because students, at the time of project planning and assignment collection, do not collect on time and some do not collect assignments in the form of project planning and reports.

The character of responsibility has an average percentage of 66.88% with the "good" category , the highest indicator is preparing the tools and materials for the project/ experiment, when the learning process takes place to conduct an experiment, students seem interested and want to participate so that each group shares the tools and materials to be used for group members. While the lowest is in the sub-indicators of completing group assignments, in the learning process students are required to complete student worksheets such as planning experiments and implementing experiments, and making reports. The character of cooperation has an average percentage of 67.77%, the highest indicator is active in group work, seen when students are active in experimenting when making preparations and during group discussions.

While the lowest sub-indicator is unity in completing project tasks, seen when assignments are not collected on time and some do not collect assignments. At the time of the learning process are contained kegi a tan pratikum, tesebut can foster students' character (Ardianto & Priyono, 2014; & Goddess & Setyaningsih, 2016) . And student character can grow through the learning process with the PjBL model (Hendikawati et al., 2016; Setiono et al., 2020) . Anggriani et al. , 2019 stated that the *Project Based Learning* model can also foster various characters, such as the character of discipline, responsibility and mutual cooperation. P Education characters that are integrated in the learning of biology is able to provide meaningful experience for the students, because they understand, internalize and download gaktualisasika nnya through p r OSes learning, and can be absorbed naturally through daily activities and can be achieved through the emotions and habits of students (Aisyah , 2014; Machin, 2014).

Student character can grow during the learning process through the *project based learning* (PjBL) model, which occurs when students have the willingness to follow and pay attention selectively to instructions that are given by themselves during their learning activities. Then with students who actively participate in the learning process, students are able to accept existing life values that are shown through student attitudes and are able to show character through student actions or actions. Students begin to build a consistent value system within themselves. Then the consistent, consistent and predictable behavior of students in their activities makes students unique characteristics (Herman & Yustiana, 2014).

The character that develops is not only seen from the results, but also in the process. Therefore, the teacher has a duty to be morally responsible for shaping the moral values of the teacher and facilitating students with each step of their learning by deliberately sharing habitual and consistent charitable actions (Hardiwinarto, 2010 & Abu, 2015).

High School Student Science Process Skills

The results of observations on students' science process skills obtained during learning activities, from project planning, project implementation, product manufacturing, to product presentation. The results of high school students' science process skills can be presented in Table 4.

Table 4. High School Student Science Process Skills

The value of each KPS		
Science Process Skills	Score (%)	Category
Observing / Observation	84.29	SB
Planning an experiment	64.53	B
Carry out an experiment	89.22	SB
Communicating	60.90	B
Average	74.73	SB

In the aspect of science process skills (psychomotor), it can be observed through observation during the learning process, based on project implementation and product manufacturing, which is in accordance with the PjBL model (Table 4). PjBL is effective against students 'science process skills (KPS), this can be seen from the average percentage of students' science process skills scores 75% with the "good" category. In KPS observing/ observations in the "very good" category. The highest indicator of observing / observation is doing experiments on preparations, when doing experiments, this is the first experience of some students in observing plant tissue, so that students are still awkward in observing, but students have a curiosity and want to try doing experiments in make preparations. Students can also collect and use relevant facts about plant tissue material based on observations during the experiment and sources obtained from books and the internet. And students can make observations according to the facts in the field on the preparations that have been made.

At KPS planning experiments and communicating in the "good" category. In KPS planning experiments, indicators determine the tools and materials to be used and determine the steps in carrying out the project / experiment, students are able to plan and write down what activities will be carried out. While the indicators determine the schedule of activities carried out until the product is finished, students still do not understand in determining the schedule of activities because in the learning process the PjBL model is rarely used. At the KPS communication, indicators describe/ describe and convey the results of the observation/ project reports, students are able to describe and convey the results of their observations through presentations in front of the class even though there are some students who have not submitted them because the results of the reports have not been completed. PjBL also has an effect on students 'communication skills, such as improving students' skills to present their projects in class (Saenab *et al* , 2018). And on the indicators of compiling reports systematically and clearly, each group did not understand the mathematics of report preparation even though it had previously been explained by the teacher, only a few groups were systematic in preparing reports. According to Nawawi *et al.* (2017) revealed that students' communication skills were increasingly visible because students completely experimented .

The highest student's science process skill was conducting an experiment in the "very good" category. The highest indicator is carrying out the steps in project activities, when carrying out the experimental process students carry out the steps according to the experimental planning that has been made and teacher guidance. Students can make project products in the form of plant tissue preparations, but some students do not record the experimental results because students are more focused on observing the preparations through a microscope. Djamarah (2010) states that through practicum students can experiment during the learning process so that students experience firsthand the material being studied and familiarize students with using science process skills and can learn individually or in groups .

Besides having a positive effect on cognitive abilities and science process skills, practicum can also motivate students to learn, and students become active in the learning process by making experiments (Muamar et al. , 2017). Practical activities in the project based learning *(* PjBL) model can improve students' science process skills , because the assessment is carried out during the activity process and not only on the final product (Sarlivanti, et al., 2014; Chasanah, 2016; Rofiqoh, et al., 2015 & Varadela, et al., 2017).

On Lestari et al . (2018) found that by doing practicum/ experiments able to grow science process skills, including observing / observing, planning experiments, and communicating in the "enough" category and conducting experiments in the "good" category. In its implementation, it is able to provide motivation in exploring knowledge, arouse interest in learning and improve science process skills. Learning *Project Based Learning* influence on science process skills, students are able to design and conduct experiments on materials that have been taught, and capable of designing and conducting experiments on any material. (Asmi, *et al.,* 2014 ; & Kusumaningrum & Djukri, 2016 ;).

Students' science process skills can grow during the learning process through the *project based learning* (PjBL) model, which occurs when students use their sensory tools to stimulate awareness, select or select relevant assignments and interpret cues from an action performance. Indirectly, students do mental, physical, and emotional preparation. Students mimic or repeat the actions exemplified by the teacher and identify appropriate responses. Then the learned responses become students' habits and are carried out based on ability. The abilities that have been obtained make skills that can be developed properly so that students can modify movement patterns according to special requirements. Then students have the ability to create creativity using very high skills (Herman & Yustiana, 2014).

High School Student Products

Project assignments carried out by students produced products in the form of plant tissue preparations and reports. In high school student products, there are several stages in the product-making process, such as stage 1 is planning, stage 2 is a manufacturing process consisting of preparation of tools and materials and manufacturing techniques. Stage 3 is the end which consists of making preparations and making reports. Preparation consists of slicing the material properly, laying the material on top of the slide, and observing the preparation being made. And in the making of the report consists of compiling a report, describing the results of plant tissue preparations, giving information on the results of the image preparations, and giving an explanation of the pictures. The results of the product manufacturing stages are presented in Table 5.

Based on Table 5 , it shows that the highest percentage of results in the product manufacturing stage is to make preparations in the "very good" category, while making lower reports with the "good" category. This is in accordance with Chasanah (2016) that the PjBL model is effective in improving students' skills when doing practical activities, because the assessment is not only on the final product but is carried out during the PjBL model activity process. As well as the assessment is carried out by making observations in each group, using indicators at each stage. Likewise, the stages of making preparations include indicators of slicing the material properly, placing the material on the glass preparation, and observing the preparations made.

Table 5. Results of Product Manufacturing Stages

Stages	Average (%)		Category
Planning Stage		66.67	B
Manufacturing Process Stage		79.2	SB
Preparation of tools and materials	83.33		SB
Manufacturing technique	75.00		SB
Final Stage		71.27	B
Making Preparations		80.56	SB
Slice ingredients properly	75.00		B
Putting material on the glass preparation	91.67		SB
Observe the preparations made	75.00		B
Make a report		61.98	B
Prepare reports	52.08		B
Describe the results of the preparations	66.67		B
Annotate the results of the preparation image	70.83		B
Give an explanation in the picture	58.33		B
Average		72.09	B

In making preparations and reports (Table 5), students make products through several stages until they reach the final stage in the form of a product. The percentage of results making preparations is greater, namely 80.6% with the "very good" category, while the percentage of results making reports is 62% in the "good" category. When students understand and implement science process skills in learning, science becomes more interesting and increases a positive attitude towards science (Zeidan & Jayosi, 2015). Learning biology will be meaningful if students are actively involved intellectually, manually and socially. The development of science process skills as a process and a product needs to be developed through direct experience, as a learning experience and to realize it when activities are ongoing (Suryaningsih, 2017; Varadel et al., 2017; Royani et al., 2018).

The project-based learning (PPA) model can train 21st century skills that are centered on students, teamwork, and learning related to the context of everyday life so that problems encountered in everyday life can be used as learning topics (Mayasari et al. al , 2016). Through *PjBL,* the *inquiry* process begins by raising a guiding *question* and guiding students in a collaborative project that integrates various subjects (materials) in the curriculum. If a teacher is successful in managing teaching-learning interactions, success will be seen in the form of student learning achievement (Gusti, 2017).

CONCLUSION

Based on the research, the ability of students at Muhammadiyah I Karanganyar high school in high-level thinking (HOTS) on plant tissue material can be increased through the Project Besed Learning (PjBL) model. As well as student character and science process skills students at the Muhammadiyah I Karanganyar high school on plant tissue material can grow through the Project Besed Learning (PjBL) model.

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