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# Ethnophysics in Learning Based on Javanese Culture to Improve the Generic Skills of Students' Science

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The aim of this research is to discover how to improve students' generic science skills through ethnophysics in a study based on Javanese culture. This research uses the method of class action and qualitative research. The subject of this research consists of 38 students of MAS PAB 2 Helvetia. The generic science data were obtained from the generic science skill instrument and then analysed descriptively by using the N-Gain trial. A qualitative method was used, in the form of interview, journal reflection and observation. The results show that ethnophysic application in learning based on Javanese culture can increase the participants' generic science skills and develop collaboration skills, as well as skills in communication, criticism and reflection, self-confidence, debate and creativity.

**Key words:** *Ethnophysic, Learning based on Javanese culture, Generic science skill.*

## Introduction

Physics is a body of knowledge, a way of thinking and a way of investigating, learning and analysing nature scientifically. The main key to teaching physics is to involve students in an active way so they have a positive interaction with the concrete objects (Supriyono, 2003). The results of observations of researchers at school show that 70 per cent of students think physics is difficult to understand and uninteresting. This is closely related to monotonous learning situations, where students are forced to sit and listen to the teacher's explanation, working on questions full of mathematical formulae, with the lessons not related to the experience of everyday students. It is suspected that this learning atmosphere generates boredom, thus affecting the activities and student learning outcomes (Carter et al., 2017; Triharyanti, 2012). Sarwanto et al. (2014) state that students' difficulties in learning physics are caused by a large part of physics material being adopted from Western science.

The culture underlying the development of Western science is not the same as that in Indonesia, so science learning has the potential to cause a clash with local science and learning outcomes have not reached the set targets. Learning should be related to student culture, not only emphasising cognitive aspects but also the attitude and psychomotor aspects – in this case, generic science skills that are necessary to solve various problems in the daily lives of students.

One method that can be used to improve the quality of learning processes and outcomes is to integrate culture in learning (Afrianawati et al., 2016; Anwari et al, 2016; Rahayu & Sudarmin, 2015; Sarwanto et al., 2014). Education and culture play an important role in fostering the development of the nation's values, which have an impact on the formation of students' character and self-confidence based on these cultural values. The values of local cultural wisdom and awareness of location and local nature need to be integrated into physics learning because they have meaning for children's learning in school (Syafitri et al., 2017). Dragana et al. (2015) state that culture plays a significant role in the quality of teaching in elementary schools in Serbia.

The implementation of the curriculum is largely determined by the teacher's ability to develop learning tools: syllabus, learning resources and media, learning models, assessment instruments, and learning implementation plans (Akbar, 2013). Integrating education and culture into the learning process not only transfers culture and cultural embodiment, but uses culture to enable students to create meaning and be creative in understanding physics concepts. Rahmawati et al. (2017) state that the integration of ethnochemistry into the model through the culturally responsive teaching approach involves students' cultural identity and nationalism, awareness of cultural differences, and the development of learning identities. Students find that new learning experiences from their cultural backgrounds have helped to develop their chemical knowledge. Indonesia is a country that has a very multicultural population. The influence of globalisation has had a negative impact on the culture of the Indonesian nation, with the erosion of regional cultural values and the spirit of nationalism caused by the clash of cultural values and those from the outside, causing the Indonesian people to lose their identity (Danoebroto, 2012). The 2013 curriculum places culture as one of the components developed from the elementary school level to high school. Thus there is an opportunity for regions and education managers to adapt, modify and contextualise the curriculum in accordance with the reality of conditions in the field, demographics, geographical, sociological, psychological and cultural factors for learners.

Javanese culture in the North Sumatra region can be used as a supporter of the learning process and is expected to foster the interest of students in learning physics. Many things can be developed from Javanese culture, both in learning and by imitating the values that exist in Javanese culture. According to data from the 2010 Central Statistics Agency, the Javanese tribe is one of the largest populations on one of the islands in North Sumatra, the second largest after the Batak tribe.

Physics learning that is developed from the perspective of local culture and organised on the basis of local wisdom related to natural phenomena and certain natural events will increase students' interest in science, making it easier to understand (Syiddiq, 2016). The application of local wisdom-based science learning models involves observing a culture in the community and then reconstructing its scientific concepts, which can in turn foster meaningful learning and student character values (Khusniati, 2014).

Based on the above explanation, the role of physics learning that includes the process of learning and local culture so that students have character and can develop their knowledge is clearly important. Students' ability to solve physical problems and their applications in daily life, as well as students' attitudes and morals, are used as a measure of the quality of education.

This research was conducted at the Madrasah Aliyah Private (MAP) Laboratory in Medan city. Research Methods is a combination of qualitative methods that focus on the culturally responsive teaching-learning approach and classroom action research. Qualitative research is carried out interpretively to understand the subject widely (Miles et al., 2014). Data-collection techniques included interviews and reflective journals.

Classroom action research in the study was conducted in four cycles with four stages: planning, implementation, observation and reflection. The value of generic science skills is obtained through the observation sheet instrument. Data analysis increased generic science skills determined by the N-gain score test (Hake, 2014), with classification (1) If N-gain> 70, high category; (2) 30% ≤ N-gain ≥ 70% medium category; and (3) N-gain <30% low category.

## Result

### *The Students' Generic Science*

*Cycle I*

The first cycle began with the planning stage, including preparation of learning schedules, learning implementation plans, student worksheets and generic science skills instruments, ethnophysical articles and socialisation of learning to research. Implementation of this cycle discussed an ethnophysical article (Article I) about *irus*, Javanese culture cookware that deals with the physics concept of the conductivity of a material. In the first cycle, the value of generic science skills was met based on the indicators shown in Figure 1.

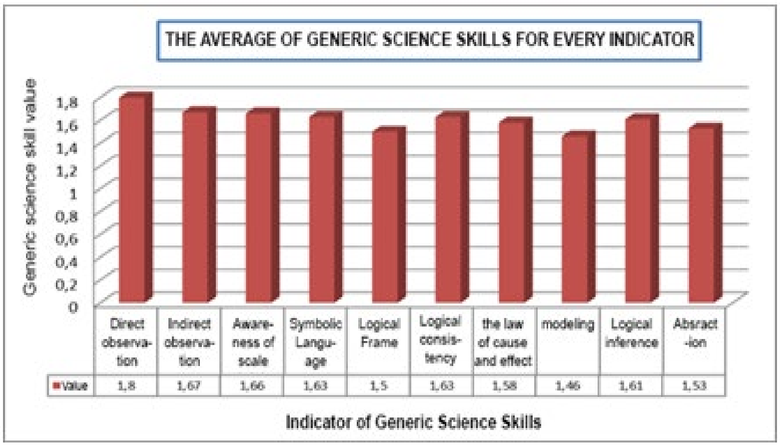


**Figure 1.** Generic science skill mark of cycle 1

Some problems faced by researchers during the implementation of learning were (1) the time designed in learning was less effective; (2) students were unfamiliar with the social interaction of Javanese culture; and (3) student worksheets and ethnophysical articles had not been integrated so that the interaction of Javanese culture and the value of generic science skills was not yet optimal.

The logical frame indicator, cause and effect law, modelling and abstraction were the focus of cycle II.

*Cycle II*

Cycle II began with preparing learning devices after considering the results of reflection on learning in cycle I. At the implementation stage of learning, the ethnophysical II article about *pawon* (a term used in the Javanese kitchen) was discussed. In *pawon*, physics is closely related to the concept of heat energy transfer about conduction, convection and radiation. The value of generic science skills based on indicators in cycle II is shown in Figure 2.

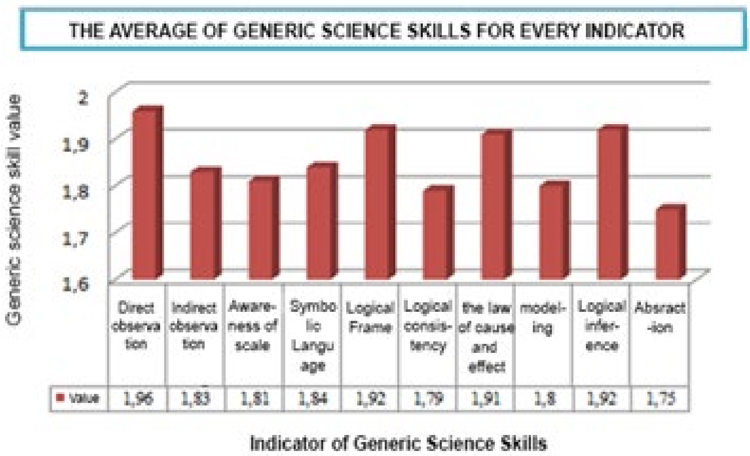


**Figure 2.** The generic science skill value of cycle II

In the second cycle stage, there were still weaknesses: (1) the Javanese social-cultural interaction in the learning syntax was still not optimal – for example, the role of students as elders or *pinisepuh* who do the work of the subordinate or vice versa; and (2) students' worksheets were still not optimal so many students still asked questions when conducting experiments. In the second cycle, the value of generic science skills showed an increase. The highest value was the direct observation indicator and the lowest value was the abstraction indicator.

*Cycle III*

The learning process in cycle III discusses ethnophysical article III about the *klepon* cake. The *klepon* cake-making process has several related physical concepts, namely the concept of volume expansion and Archimedes' law. The value of generic science skills for each indicator is shown in Figure 3.

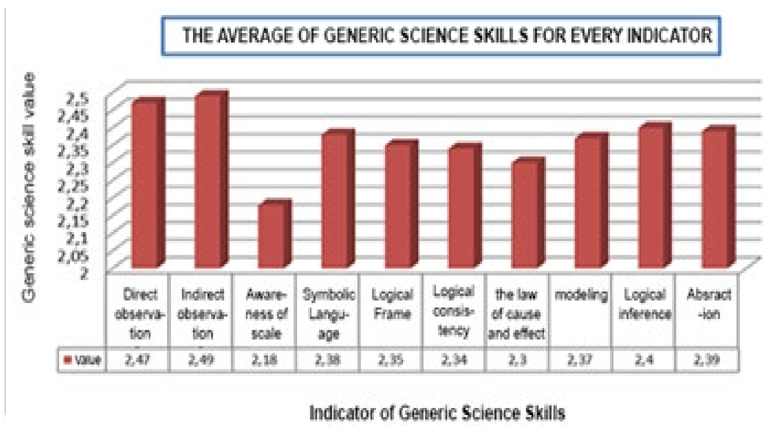


**Figure 3.** Generic science skill of cycle III value

Cycle III was done well, as shown by the results of generic science skills, but a few weaknesses in learning remained, namely: (1) in cycle III researchers still needed to remind students about the social interaction of Javanese culture; and (2) writing errors and language contained in the learning implementation plan and student worksheets needed correction. In Cycle III, Javanese cultural interaction went well, with students acting in accordance with their respective roles, and the value of generic science skills very good. The researcher evaluated the lesson plan, and the LKPD results still showed writing and language errors.

*Stage IV: Biological science learning model base and Turgo's local wisdom managing biodiversity*

At this stage of planning, researchers prepared learning devices after reflection on learning in cycle III. At this stage of the implementation of learning, discussion was about ethnophysical IV articles about Batik, one of the internationally recognised assets of original Indonesia. Batik is synonymous with Javanese people. In Batik, physics is closely related to the concept of capillary material. The value of generic science based on indicator skills at the cycle IV meeting are shown in Figure 4.

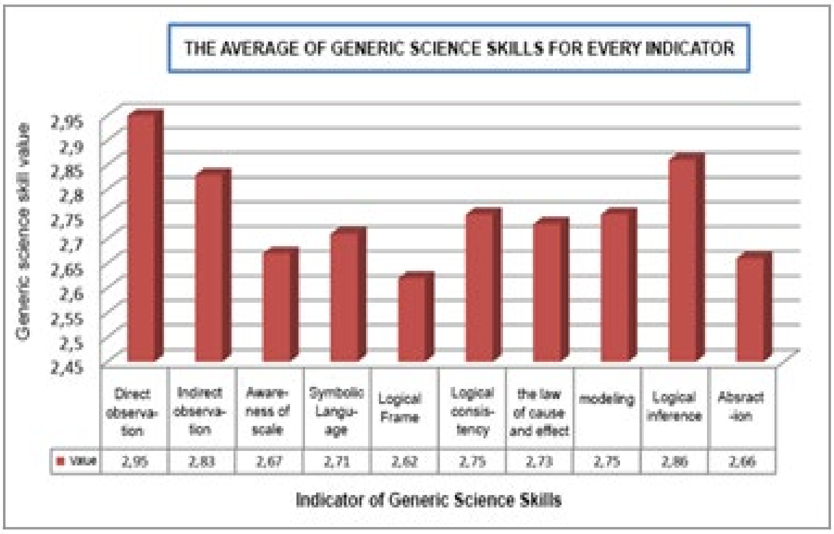


**Figure 4.** Generic science skills for cycle IV

Cycle IV was successful, with students becoming familiar with the tasks and roles in learning. The results of generic science skills have also been good. Ethnophysics through learning integrated with Javanese culture is one alternative that can be used in learning because this learning is easy to apply.

***Description of Students' Generic Science Skills***

Based on the results of the analysis of each cycle, it was found that the students' generic science skills showed an increase. The enhancement of the value of generic science skills of students in each cycle is shown in Figure 5.

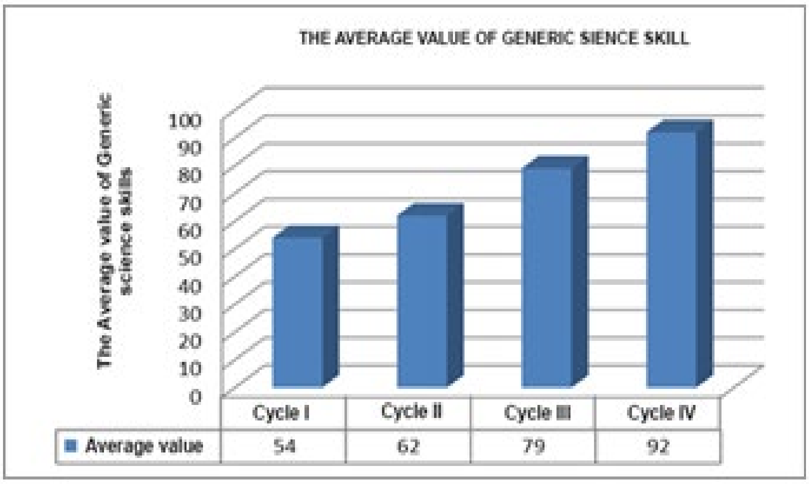


**Figure 5.** The average value of generic science skills

The increase in the value of generic science skills in each cycle for each indicator can be seen in Figure 6.

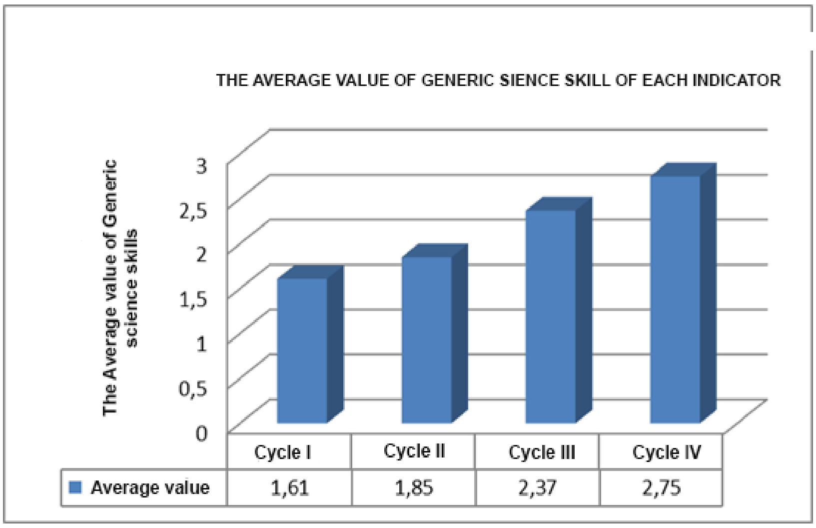


**Figure 6.** The average value of generic science skills of each indicator

The N-gain generic science skill in detail is shown in Figure 7.

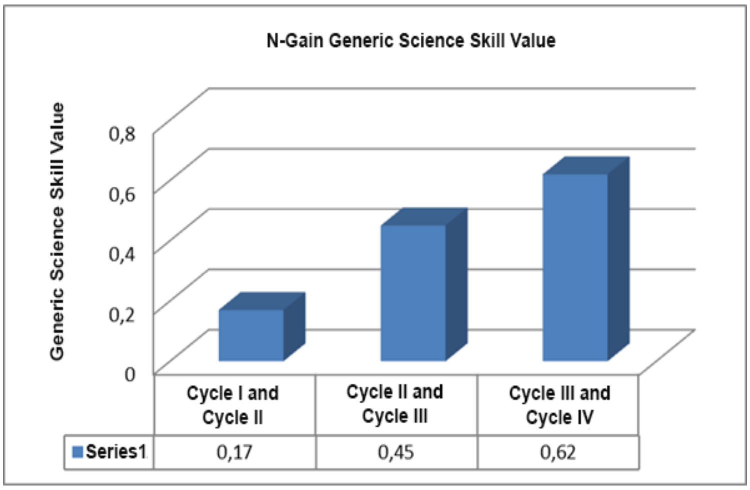


**Figure 7.** N-gain generic science skill value

Table 1 shows the average value of each generic science skill indicator obtained.

**Table 1:** Generic science skill improvement for each indicatorq456 ,

| No | Indicator | Meeting | | | | Average |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | |
| 1 | Direct observation | 1.80 | 1.96 | 2.47 | 2.95 | 2.29 |
| 2 | Indirect observation | 1.67 | 1.83 | 2.49 | 2.83 | 2.20 |
| 3 | Awareness of scale | 1.66 | 1.81 | 2.18 | 2.67 | 2.08 |
| 4 | Symbolic language | 1.63 | 1.84 | 2.38 | 2.71 | 2.14 |
| 5 | *Logical frame* | 1.50 | 1.92 | 2.35 | 2.62 | 2.10 |
| 6 | Logical consistency | 1.63 | 1.79 | 2.34 | 2.75 | 2.13 |
| 7 | Cause and effect law | 1.58 | 1.91 | 2.30 | 2.73 | 2.13 |
| 8 | Modelling | 1.46 | 1.80 | 2.37 | 2.75 | 2.09 |
| 9 | Logical inference | 1.61 | 1.92 | 2.40 | 2.86 | 2.20 |
| 10 | Abstraction | 1.53 | 1.75 | 2.39 | 2.66 | 2.08 |

Table 1 shows that each indicator of generic science skills of students increased in each cycle. The highest indicator is direct observation and the lowest indicator is an indicator of awareness about scale and abstraction. This illustrates that applying ethnophysics in Javanese culture-based learning can develop direct observation skills. By using their senses, students are able to discover their own physics concepts, which when conducting experiments support the ethnophysical articles provided. The lowest indicator on the indicator is abstention. This shows that the weakness of students in the abstraction indicator must be of particular concern. In this physics learning, it is expected that many sketches, drawings and animations will be provided and students will be directed to abstract concepts that are presented in daily life through analogy, so that learning becomes more meaningful.

**Discussion: Advantages of Ethnophysics in Learning Based on Javanese Culture**

Learning ethnophysics with culturally responsive teaching combines physics with the cultural wisdom of society. Physics is used to study science related to certain local cultural systems. Ethnophysics in Javanese culture-based learning has many advantages, including being able to encourage students to think about more complex ideas.

***Meaningful Learning Experience***

Combining physics learning with Javanese culture provides the ability to offer students interesting and meaningful learning experiences. They are given the opportunity to learn by actively participating in meaningful learning activities in addition to being able to develop their character and identity as part of their own culture. Students who showed enthusiasm and a high sense of curiosity during learning as stated:

> *We are happy with the learning experience today because Javanese culture is indeed unique in teaching us in association and attitude to the elderly, to peers, and to people who are younger than us. (Student interview, November 2018)*

> *We were shocked when presented with articles on Javanese culture when we first cooked* irus *or spatula which could be integrated with physics learning but apparently could be explained through physics. Apparently, physics is unique. (Student interview, November 2018)*

One example of an interesting learning experience for students is when they discuss the concept of properties of the *irus*. Each group debates and gives their arguments:

> *We, from the group of three elders, said that in our place, the spoon in the picture was not named* irus*, but was flat (*centong*) while the elders from group one said that the* irus *was called* sutil.

> *The excess of* irus *according to elders from group three is not easy to heat because wood is insulating and environmentally friendly.*

> *Other groups responded, 'But why do people rarely use* irus *wood now, even though it is environmentally friendly?'*
>
> *The group two elders added that* irus *and* centong *wood was considered ancient, but beneficial in terms of physics and better health. Other groups responded that* irus *was indeed better for delivering heat, but in the end, it is coated with wood or plastic so that it is not hot and is not easily corroded – indeed, plastic spoons are not good because they can cause illness.*

Students were very enthusiastic about this learning. They were able to express ideas about reality that are encountered in everyday life. Even researchers did not always not think about some of the ideas students were developing. Each group learns to express their opinions and tries to maintain their opinions. They provide arguments on matters of physics, health, and the environment. This debate provides new knowledge for students about the relevance of the concepts of physics in their daily lives.

***Student Skill Development***

The results of the study show that learning using the integration of Javanese culture and ethnophysical articles has developed the learning creativity and attitudes of their students, such as learning to collaborate with others through discussion and mutual respect. Students are interested and motivated to learn physics through the issues in the articles, then these issues are analysed and cultural values generated, impacting the identity of students and their ability to solve problems together through discussion.

***Collaboration and Interaction with Learning***

Learning experiences provide opportunities for students to develop meaningful learning in discussions, debates, conducting experiments, processing data and communicating. Class observations show that students have a positive attitude towards working with friends. In the first and second meetings, students were still confused about assignments in groups, but in the third and fourth meetings, students had become familiar with this process, and understood their position in the group:

> *At the beginning of learning, we were still confused about the concepts of elders, noblemen, clerics and young people. Sometimes our elders carried out the tasks of the* wong cilik *or vice versa, but after getting used to this discussion, we were taught to behave to understand that and humans cannot live alone. (Student Interviews, November 2018)*

Another student said:

> *We are happy to be able to work together and discuss, sometimes even our fellow citizens disagree, but our elders are wise as mediators and decision makers for input from* pinisepuh *and* aji sepih. *(Student Interviews, November 2018)*

> *Learning by connecting physics concepts with Javanese culture makes learning activities fun in the classroom. We in the group play an active role in conveying creative ideas in solving problems in the article and even a lot of the knowledge we get here. (Student Interviews, November 2018)*

Students showed that they had been able to develop collaborations, especially to implement learning integrated with Javanese culture in discussing integrated physics concepts in Javanese culture. They had learned that a concept of physics exists in Javanese customs.

***Communication***

Communication is needed in learning physics. When conducting experiments and group discussions students can share differences of opinion with other students by respecting each other's position. They learn to respect the differences between them, not only within groups but also with other groups.

> *In the presentation of the group discussion, I acted as an elder, initially insecure because I thought I was finished because I had many questions and input from other groups, but with the support of group members, I became excited and happy in a percentage of group discussions. (Student Interviews, November 2018)*

> *Discussing communication in groups and between groups has gone well and each group member has understood their respective duties. (Student Interviews, November 2018)*

Elders, clerics, clerics and *wong wilik*/small community were willing to convey their ideas to the group. In addition, students learnt to respect each other and appreciate the ideas or opinions of other students.

***Critical and Reflective Thought***

Critical and reflective thinking was developed when students held group discussions about various cultural articles. During group discussions and in the percentage results of group discussions, students also learnt to listen to the opinions of others. They began to express their own ideas before understanding other people:

> *When I debated Javanese cultural articles, there was a lot of input and criticism from other groups, but all of our group members tried to find good arguments to support my opinion so that the discussion was active. (Student Interviews, November 2018)*

> *I like to discuss with groups and listen to their statements; I like to refute their statements. But I also respect and respect different opinions. (Student Interviews, November 2018)*

The researcher directed students to read the article quietly and think about understanding articles and answering questions, so that students could have arguments to defend their views. Students were interested in learning physics through problems related to everyday life:

> *After learning about the* klepon *cake article, I gained new knowledge such as when the cooked* klepon *cake did not affect the mass of the* klepon *cake. The mass of the cake when raw remained when it was cooked and when it was cold it remained. (Student Interviews, November 2018)*

> *After learning about this article, I learned that the* klepon *cake floats because when the* klepon *cake is boiled its size increases so that it affects the density of the cake. (Student Interviews, November 2018)*

Based on interviews, it was shown that students had positive learning experiences as a reflection of the articles discussed. Students become more aware of the application of the physics. The connection with the physical concepts of their daily lives made them more motivated to learn physics.

***Confident Skill and Argumentation***

Confidence is one student attitude that need to be developed in learning experiences, especially in expressing their ideas. Students develop arguments and exchange of ideas, such as the following student statements:

> *When I as the village head gave an opinion to the opinion group, it was accepted and all group members agreed. (Student Interviews, November 2018)*

> *As an elder I accept ideas and accommodate all ideas of group members and do not discriminate so that all members of my group are eager to express their opinions and do not want to be outdone by other groups. (Student Interviews, November 2018)*

> *I like to debate the answers of other groups and am proud that I can criticise the answers expressed. (Student Interviews, November 2018)*

The results show that ethnophysics in Javanese culture-based learning helps to provide new experiences in the classroom so that students can enjoy learning physics and connect more with the subject.

***Creativity***

This Javanese culture-based learning has helped students to develop their creativity, not only in finding different solutions to problems, but also in developing creative ideas:

> *As a teacher, I see that ethnophysics in Javanese culture-based learning helps us in enriching our understanding of the variety of learning styles that exist and by integrating learning with culture in the classroom. (MAS Physics BA 2 Teacher Helvetia Interview, November 2018)*

According to Muhammad Nuh (2018), as a facilitator Tanoto Foundation said that students' physics learning must go through a process of direct experience, engaging in interaction, communicating and reflecting. This concept is known as MIKIR. Vygotsky in Arends (2013) adds that social interaction with other people, both teachers and peers, can refer to the construction of new ideas and enhance the intellectual development of learners.

This is in line with the results of Arfianawati, et al. (2016). Students who gain knowledge through direct experience will be able to improve students' cognitive abilities, which shows that the average student learning outcome increases after the application of biology learning based on local cultural sciences. Ethno-science based learning models are closely related to everyday life, so they can help students to understand the subject matter.

The results of Tamimi's et al.'s (2015) study showed that the physics-based learning of culture motivates students' interests and understanding, and plays an active role in their interest in the physics material studied because it reminds them of Indonesian culture and national character. Khusniati (2014) states that a science learning model based on local wisdom by observing a culture in the community and then reconstructing its scientific concepts is able to develop the conservation character values of students. With regard to the results of other studies, Arfianawati et al. (2016) states that the application of ethnic-based chemistry learning models can improve cognitive abilities and critical thinking because the learning model links learning in the classroom to what students encounter in their daily lives and also encourages them to play an active role in the process study. The application of an ethnic approach in learning is very diverse, depending on the environment of students. Educators who use this approach therefore need to have a deep understanding of their local knowledge. Mujadi (2015) states that physics can be easy to learn and can motivate students if the learning process of physics-science values of art and culture are involved.

## Conclusion

Data analysis shows that ethnophysics in physics learning based on Javanese culture can improve the generic skills of students. Indicators of generic science observation skills directly have the highest increase and awareness indicators about scale have the lowest increase. In addition, this culture-based learning can develop collaboration, communication, critical and reflective skills, confidence, debate and creativity.

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