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Article

Application of Ethnophysics integrated with Culturally Responsive Teaching (CRT) methods to improve Generic Skills of Indonesian Science Students

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Abstract

The main premise of this study is that learning of physics is associated with students' cultural background. The study utilized characteristics of Culturally Responsive Teaching (CRT) as learning phase which involved collaborative teaching, responsive feedback, modeling, and instructional scaffolding. The objective was to determine the improvement in the generic science skills in students through Batak culture-based learning of Ethnophysics, and to analyze the application of Ethnophysics integrated in CRT to the learning of physics. This classroom action research conducted in a Senior High School in Indonesia involved a qualitative approach completed in four circles, each consisting of four stages (planning, implementation, observation, and reflection). The sample consisted of 26 students, and the research parameters included static fluid material, momentum, and impulses, sounds, and pipes. The data were collected through interviews, reflective journals, observations, and instruments of generic science skills, and analyzed descriptively. The results showed that generic science skills of students (a) increased during each meeting (b) was found in medium category after data analysis via the n-gain test. The study concludes that the application of Ethnophysics in learning based on Batak culture improves the generic science skills of students.

Keywords

Ethnophysics • collaborative learning • batak • culture learning • generic science skills • Indonesia

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Introduction

Physics is one of the branches in science that studies, describes, and analyzes natural phenomena. It is described as a body of knowledge, a way of thinking, and investigating. An important aspect of learning physics is the active involvement and interaction of students with concrete objects (Supriyono, 2003). Middle school students usually consider it as a difficult, scary, and less interesting subject. This is partly due to classroom conditions being highly monotonous when students are forced to sit for hours listening to the teacher and making them feel that they are in another world. The experience of students in a classroom is inversely proportionate to the reality they live in. The teacher, as an educational subsystem, has to be responsive to the development of culture and local wisdom, technology, and art in the environment, for building curiosity which is a requirement for learning. The construction of real and illustrative experiences in the learning process is necessary in the classroom, where there are only books, notes and a series of teacher's commands. Such conditions lead students to boredom which affects learning activities and outcomes. From the concepts of physics and its learning objectives according to the Ministry of National Education of Indonesia, Regulation No.21 2016, it aims to achieve competencies set out in the 2013 curriculum content standards. The achievement of these competencies is inseparable from the strategies, models, techniques, and methods appropriate to the cultural and daily characteristics of students.

Indonesia is a country with a highly multicultural population. Along with the times and influence of the current era, globalization has dealt with a negative impact on its culture, with the erosion of regional cultural values and the national spirit caused by the clash of cultures from overseas, thus making it seem that the country has lost its identity (Danoebroto, 2012; Cancar, 2018; Aydin, 2019; Dunga & Mafini, 2019; Armijos-Bravo, 2019; Akkaya, 2019). The regulations of the Indonesian Ministry of Education and Culture regarding the implementation of the 2013 curriculum requires local content lessons for introducing students to their social, natural, and cultural environment. The effort seems to be mainly unsuccessful in achieving its goals, which is evidenced by many students presently not being familiar with their own culture. Thus, a culture-based learning approach is needed for a physics learning solution in schools to make it contextual. Teachers need to be illustrative by constructing real experiences in the learning process of Physics which enhance the preservation of good student grades and scores, thus reflecting their ability (Derlina, Dalle, Hadi, Mutalib, & Sumantri, 2018).

One learning model that is applied in the learning of physics is culturally responsive teaching (CRT), which involves the ability to communicate clearly a specific cultural knowledge to students (Cahnmann M. , 2005; Cahnmann & Remillard, 2002; Mitchell, 1998). Culturally responsive teaching also creates diverse student performance styles which provides meaningful learning experiences and enhances genuine respect for their different cultures (Scheurich, 1998). Its strategies use challenging and interesting exercises occurring in the context of students' cultural and linguistic backgrounds (Hilberg, Tharp, & DeGeest, 2000; Athiyaman & Magapa, 2019; Akbas et al., 2019; Bonal et al., 2019; Maake & Tranos, 2019; Helmar et al., 2018). Furthermore, it helps to shape their identities and develop cultural, language, and racial identities.

This study discusses physics learning process by making students actively participate in order to enhance their generic skills, and entail learning of Ethnophysics based on Batak culture integrated into the CRT learning model. Ethnophysics learning is a strategy to create learning environments and formulate learning experiences and integrate culture into the learning process. It is based on the recognition of culture as a fundamental part of education, expression and communication of ideas for the transmission of knowledge. Ethnophysics learning based on Batak culture is very suitable for improving generic science skills, which are highly important for solving scientific problems, and understanding and learning abstract concepts. In general, this requires high reasoning abilities, which are obtained by learning methods that demand reasoning. Students are therefore trained to use reasoning in understanding concepts in addition to applying empirical experience.

From the description above, in order to overcome problems associated with the low generic science skills of students, it is particularly important to determine the improvement of these skills through Ethnophysics in Batak culture-based learning, and to analyze the application of CRT in the learning of physics. This research is a culture-based study in which learning physics is associated with students' learning culture. The researchers of the study identified what learning culture students follow and attempted to connect physics with their cultural backgrounds. This was carried out via a study using the characteristics of CRT as a learning phase developed which involve collaborative teaching, responsive feedback, modeling, and instructional scaffolding.

Literature Review

The concept of culturally responsive reaching (CRT) involves the usage of the cultural knowledge of different types on the basis of which effective learning experiences can be developed. According to the concept of culturally responsive (CR) pedagogy, the concept of CRT involves effective cooperation between teachers and students so that better learning experiences can be imparted to students. Generally there are five stages that are involved in the CRT. The first step is the identification followed by the proper understanding of a culture. The next steps include collaboration, critical reflections and finally transformative construction. As far as the generic skills of the students are concerned, the most important of them is employability skill through which the knowledge can actually be applied. These generic skills are required in different disciplines especially at workplaces and in general life (Sinulingga & Sinaga, 2019). The practical implementation of these skills is very important and this is especially emphasized in case of physics learning and implementing the learned knowledge in life. This not only enables the students to increase the capability and skill set of the students but also assists them to increase the thinking and reasoning skills so that they can think in a systematic and creative way.

There are some skills that are really important with regard to putting and emphasizing on the processes such as observation skills, classification skills, measurement skills, communication skills, data interpretation skills and finally the experimentation skills. These skills must be imparted to the students based on their thinking capacities as well as the structure of the curriculum (Zidny, Sjöström, & Eilks, 2020). Different indicators have been recognized that are related to the learning process especially in a scientific learning process. These indicators include direct and indirect observation, language, scale awareness, logic, cause and effect, concepts building and mathematical modeling. All these are environmental factors. Ethnophysics is one such learning strategy that makes use of the learning environments and transform them into learning experiences along with culture as a fundamental part of the learning process. Oxford's Dictionary defines the word 'Ethnology' as a term that revolves around the study of people's characteristics as well as the relationships between them. More specifically, the concept of Ethnophysics revolves around the study of people, culture and overall environment (Risdianto, Dinissjah, & Nirwana, 2020). The inclusion of Ethnophysics in the curriculum of the school provides students with the opportunities to show their potential and talent. The basic concept of Ethnophysics revolves around the idea of the original knowledge system in which major practices and concepts are related to those myths and supernatural aspects that are either based on the environment or have been enforced through the culture. The classes of Ethnophysics involve the development of those practical models in which the original knowledge system is found along with development and change.

There are five major aspects that are related to the study of Ethnophysics. The first is the assessment or study of a society in its original condition or situation. The second is the culture based or culture related references of the term (Abdurrahman, Suyatna, Distrik, & Herlina, 2018). The third is the integration of knowledge and technology aspects of various sectors as a part of holistic approach. The fourth is the assessment or study of a society when the external i.e. western or non-western knowledge is integrated in the society. The last is the comparison of these western or non-western aspects in societies and cultures. As far as the rationale of combining Ethnophysics and school syllabus is concerned, science is based on the preconception, culture and the common sense of people. The concept of Ethnophysics revolves around the idea of a child who develops the images of the environment in which they are living and are experiencing it and in the process of image making, the purpose of developing the image is fulfilled and the gap present between the reality of life and the learner is bridged.

On the learning front, learners get a lot of aspects through Ethnophysics (Nurso, 2019), which includes construction of reality. As discussed earlier, Ethnophysics involves the knowledge about the original culture. Therefore, reality can be constructed by integrating the culture with the modern knowledge of science. In other words, Ethnophysics act as the intermediary between theater and technology or between fantasy and actual knowledge. It can also be stated that a person's mind can be shifted to the external world through observation and manipulation through Ethnophysics. Apart from this, the anthropological data can also be systemized using Ethnophysics (Risdianto et al., 2020). As it serves as the linkage through which children connect their culture with the modern scientific knowledge, therefore, if these children are exposed to anthropological data, their supernatural abilities might be enhanced and the predominant role learning process can be lodged in the students. This is because of the reason that students now have the ability to make a comparison and can interlink stuff in the class of Ethnophysics. Lastly, the false thinking of people can also be clarified through Ethnophysics. Different traditions from various cultures and science related problems can be reflected through Ethnophysics. The scientists from the west have rejected the Ethnophysics and the reason of their rejection is based on their thinking that their developed methodology is not totally followed in Ethnophysics. It is quite clear that monopoly of truth is possessed by no one and there is no best method of knowing except the intuitive and conceptual methodology that has been developed through the various cultures classrooms.

In the context of Ethnophysics and related skills acquisition, it must be noted that a gap is found between the culture of students and a new field of subject, which must be bridged (Ani, Intan, Irkham, & Muhammad, 2019). The inclusion of Ethnophysics in the syllabus of the schools facilitates students to make models of practical nature through a balanced and developmental approach. There are however courses and disciplines in which the inclusion of Ethnophysics might play an important role. In field of music, for instance, the traditional musical instruments related to a particular culture can be recognized by students. In addition, they might also be able to elaborate the background idea of those musical instruments, their functionality and the sounds produced by them (Silvini & Ginting, 2020). More importantly, the method through which the musical sounds are produced by the musical instruments can also be explained by Ethnophysics students. The comparison between music instruments and related aspects can also help obtain the differences between the country of origin and a foreign country or culture. Brandy making is another discipline in which students might get skilled through Ethnophysics. The process of distillation is quite important and this technology can be elaborated by experts who might explain the overall process of distillation. The local trap making is another aspect of acquisition of Ethnophysics which teaches them how to impart the overall process and mechanism of trap making. The experiences in this regard are obtained from animals that are trapped in the process. The teachers might use these aspects to give the students a challenge in classes to interpret the trap making process along with the forces that are involved in trapping process.

Physics is considered to be the basis of certain technological advancements in developed and developing countries as well. Hence, it may not be difficult to integrate Ethnophysics with the school syllabii (Sinulingga & Sinaga, 2019). The subject has some qualities that are generally accepted and are expected to increase the scope of the knowledge and understanding of learners. These aspects are considered necessary because if these are properly integrated with the school syllabi, the subject will become much easier to understand. The syllabi of Ethnophysics must be innovated by taking certain steps (Zidny et al., 2020) like developing a network based on the hybrid concept and designing strong linkage and integration of all its components. Moreover, the syllabus must be designed in such a manner that concepts and techniques must be introduced in a hybrid way, and by interlinking the cultural backgrounds of different countries and regions. This linkage might involve certain departments or institutions on international level such as CIKARD or Center of Indigenous Knowledge for Agriculture and Rural Development.

Such linkages and integration will help to transform classes into incubators of technology and innovation. A need will therefore be felt to develop instructional related to community science education dependent on concepts and practices. When linkages and bridges are built between different centers of indigenous knowledge, either at local or international level, a new type of classroom module can be developed (Risdianto et al., 2020). This new module will be the basis through which a more unified form of knowledge can be delivered to students irrespective of their cultural backgrounds. The aspect of entrepreneurship can also be focused while developing the classroom syllabi for science. Although a number of technologies have been developed by indigenous centers of knowledge, the method of integration of these technologies has not been quite clear. There is a need to make these technologies integrated in the science classrooms with the purpose of their improvement. Another way through which this objective can be achieved is to develop the indigenous technology centers just like the knowledge centers. A new kind of multi-lingual science education model can also be introduced so that the indigenous knowledge systems in different countries and cultures can be utilized (Abdurrahman et al., 2018). Thus the literature in this regard has been covered in context of the integration of culturally responsible teaching with Ethnophysics in cooperative learning systems, so that the generic skills of the students can be improved.

Methods

This action research study involved a qualitative approach method conducted in four cycles, each consisting of four stages namely planning, implementation, observation, and reflection. Each cycle was completed during the reflective stage of learning before proceeding to the second, and each cycle followed the same steps as the previous. The research was conducted in Senior High School (SMA) Negeri 1 Tambangan, Mandailing Natal District, North Sumatera, Indonesia, class XI Science 1, during the second semester, 2017/2018 academic year. The sample size was 26 students and the parameters to study included static fluid material, momentum, impulses, sounds, and pipes.

Data collection techniques included interviews, reflective journals, and observations with students as instruments of generic science skills. The data analysis technique was a class action case study with results that were not generalized. The improvement in generic science skills was analyzed with the N-gain test, and each research variable was analyzed by referring to the established criteria.

Results and Discussion

Cycle I

The first cycle began with the planning stage which involved preparation of learning schedules and implementation plans, student worksheets, and generic science skill instruments, Ethnophysics articles, and research on learning socialization. The implementation of this cycle discussed the Ethnophysics article I utilizing the traditional method which involved the use of cooked (boiled) eggs placed in water. The boiled eggs would sink while the rotten ones would afloat, which is contextually related to the physical concept of static fluid. The results of the application of Ethnophysics article 1 are shown in Figure 1, which presents the score of generic science skills while Figure 2 shows the average scores of generic science for all indicators.

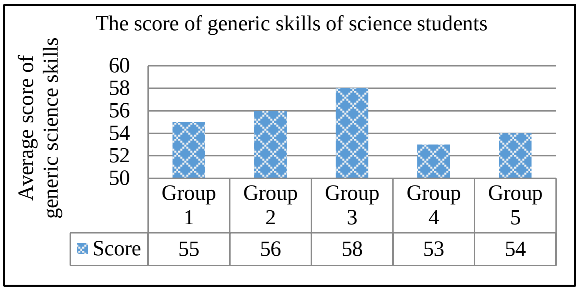

Figure 1. Score of generic science skills in Ethnophysics class (Article1)

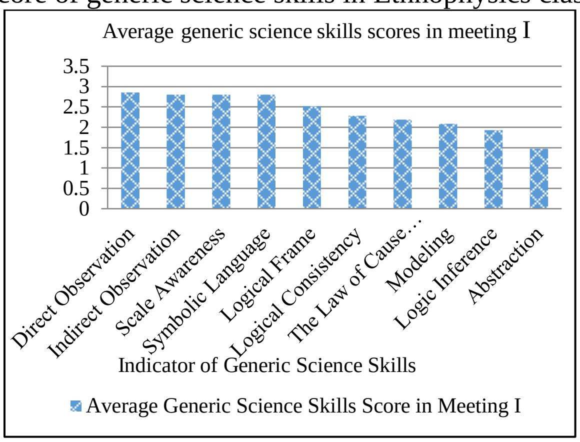

Figure 2. Average skill scores of generic science for all indicators (Cycle 1)

Cycle II

Cycle II began with preparing a learning implementation plan, Ethnophysics articles, worksheets for students, and generic science skill instruments after considering the results of learning reflection in cycle I. The implementation stage of this cycle discussed Ethnophysics article II which was on Marcungkil. It is a traditional game which, in physics, is closely related to the concepts of momentum and impulse. The results of the application of Ethnophysics article II are shown in figure 3. Moreover, figure 4 shows the details of the average generic science skills of students, as well as scores of all indicators.

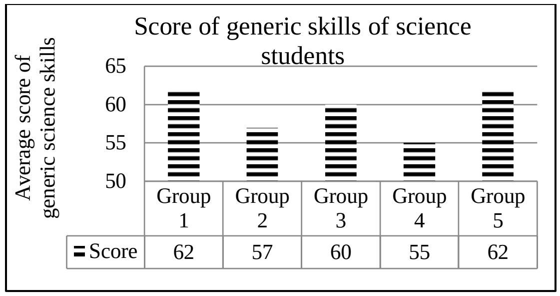

Figure 3. Score of generic science skills in Ethnophysics class (Article2)

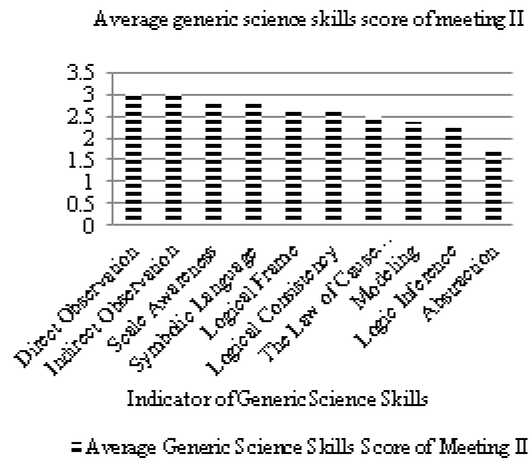

Figure 4. Average skill scores of generic science for all indicators (Cycle 2)

During cycle II, there weaknesses in learning was noticed, which included (1) Batak socio-cultural interaction in the learning syntax was not optimal, for example, the role of students of Mora, Kahanggi culture doing Boru children's assignments or vice versa, (2) student worksheets were also not optimal, therefore, many students asked questions during experiments. In this second cycle, Batak cultural interactions became increasingly successful, and the score of generic science skills showed improvement. The highest scores were both direct and the indirect observation indicators, followed by scale awareness and symbolic language.

Cycle III

In the planning stage of this cycle, researchers prepared a learning schedule, implementation plan, Ethnophysics article II, student worksheets, and generic science skill instruments by considering the results of the weaknesses of cycle II. Its implementation was discussed in the context of Ethnophysics article III, on the Tor-tor Traditional Art of the Mandailing Tribe. Tor-tor dance is always performed with Gordang Sambilan wasps. When Gordang Sambilan is eaten, there are related physical concepts such as sound, color, and frequency. The results of the application of Ethnophysics article III are shown in figure 5, including the scores of students' generic science skills. Moreover, Figure 6 shows average score of generic science skills in Cycle III for each indicator.

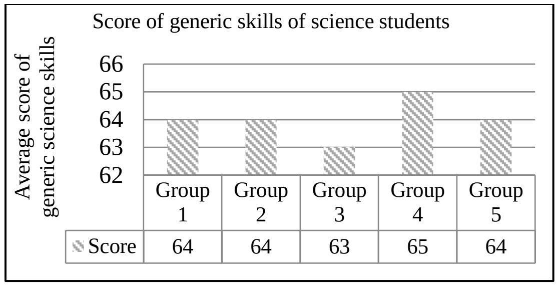

Figure 5. Score of generic science skills in Ethnophysics class (Article3)

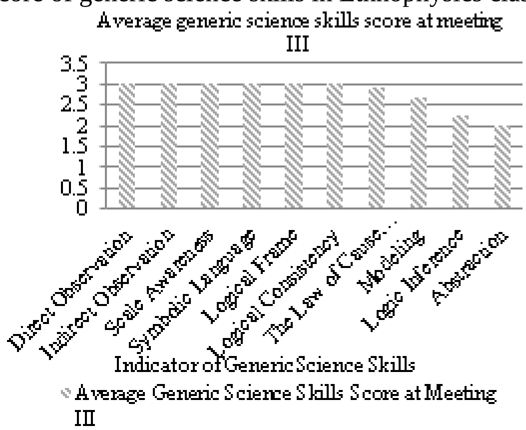

Figure 6. Average skill scores of generic science for all indicators (Cycle 3)

The cycle III was successful, which is vivid in the results of generic science skills. However, there are a few weaknesses found during learning which included Batak socio-cultural interaction and correction of writing and language errors found in the lesson plan and students' worksheets. In this cycle, the Batak cultural interaction was successful, as students played their respective roles, and the score of generic science skills was also good.

Cycle IV

In the planning stage of this cycle, researchers prepared a learning schedule and implementation plan, Ethnophysics articles, student worksheets, and instruments of generic science skills after considering the reflection of learning in cycle III. The implementation of this cycle discussed the Ethnophysics article IV, which is Gordang as a Musical Instrument in Mandailing. The other musical instruments aside Gordang Sambilan are momongan, sarune, ogung/gong, doal, and sasayak rope. The Sarune produces sounds associated with physics as can be seen in sound of organ pipes. The implementation results of Ethnophysics article IV are shown in Figure 7, alongside details on the scores of generic science skills. Figure 8 presents averages score for all indicators.

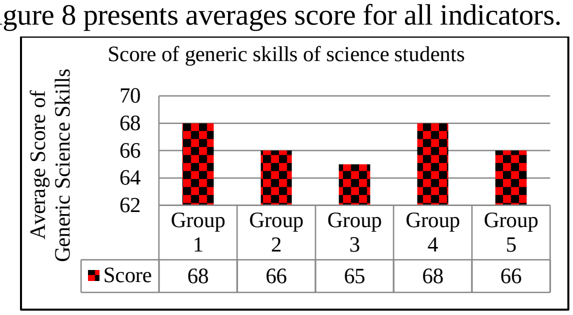

Figure 7. Score of generic science skills in Ethnophysics class (Article4)

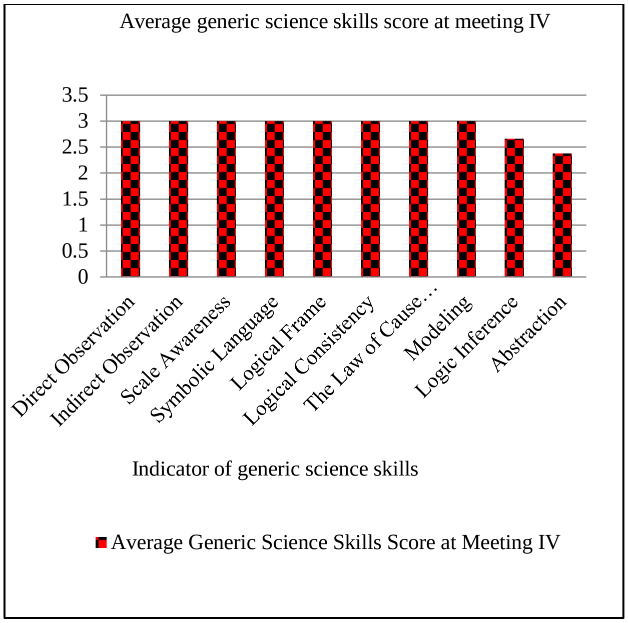

Figure 8. Average skill scores of generic science for all indicators (Cycle 4)

Every indicator at the reflection stage of Ethnophysics learning was successful. Learners were familiar with the task and its role in learning. The results of generic science skills were equally good.

Results of Data Analysis of Students' Generic Science Skills with N-gain Test

From the analysis of each cycle, it was found that their generic science skills showed improvement. This is observed from the average scores of students in each cycle in Figure 9. The average scores for each indicator are presented in Figure 10. The N-gain score is represented in Figure 11, and the average of all indicators in Table 12.

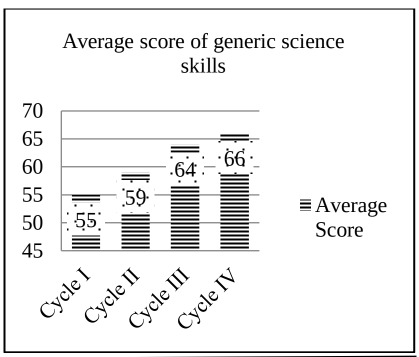

Figure 9. The average score of generic science skills

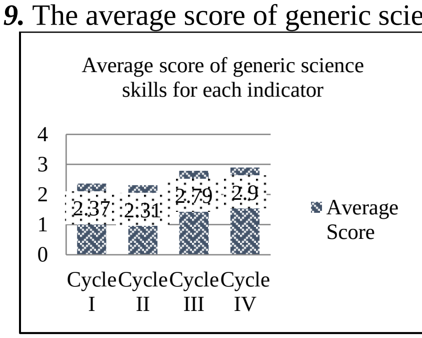

Figure 10. The average scores for each indicator

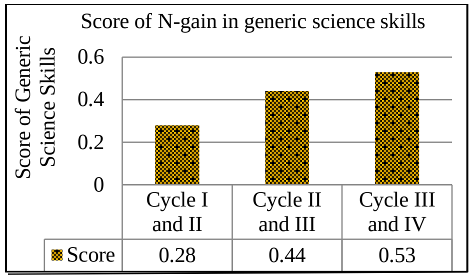

Figure 11. The N-gain score of generic science skills

Table 1. Average Scores of Each Generic Science Skill Indicator

No	Indicators	Meeting				Average
		I	II	III	IV	
1	Direct Observation	2,86	3,00	3,00	3,00	2,97
2	Indirect Observation	2,80	3,00	3,00	3,00	2,95
3	Scale Awareness	2,80	2,80	3,00	3,00	2,90
4	Symbolic Language	2,80	2,80	3,00	3,00	2,90
5	Logical Frame	2,52	2,61	3,00	3,00	2,78
6	Logical Consistency	2,28	2,61	3,00	3,00	2,72
7	The Law of Cause and Effect	2,19	2,51	2,90	3,00	2,65
8	Modeling	2,09	2,38	2,70	3,00	2,54
9	Logic Inference	1,93	2,33	2,25	2,66	2,29
10	Abstraction	1,47	1,69	2,00	2,38	1,89

From Table 1, it is observed that each indicator of generic science skills increased significantly during each meeting. The highest or easiest indicator that can be mastered by students is direct observation, while the lowest / hardest is carrying out logical inference and abstraction. This illustrates that the application of Ethnophysics in learning based on Batak culture provides a direct learning experience. According to Liliasari (Sayak, Sahputra, & Lestari, 2017), direct observation demands the ability of humans to observe objects directly and look for causal links from these observations. In this indicator, students made observations of items through the sense of sight. The lowest score in all the indicators is abstraction. It shows the weaknesses of students in abstraction, which poses a major concern. In learning physics, a lot of sketches, drawings, and animations are necessary, and students require a direct analogy of abstract physics concepts related to everyday life, in order to meaningfully enhance learning.

Relationship between Ethnophysics in Learning Based on Batak Culture and Generic Science Skills of Students

Regarding learning based on Batak culture, Ethnophysics articles played an essential role in increasing the scores of generic science skills in students. From the results, it is observed that there is an increase in generic science skills when taught through Ethnophysics in Batak culture-based learning in each cycle. Figure 12 attempts to show the relationship between Ethnophysics Learning Based on Batak Culture and Generic Science Skills of Students

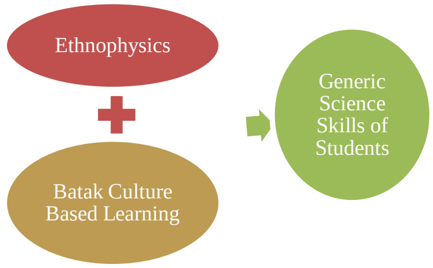

Figure 12. The relationship between Ethnophysics Learning Based on Batak Culture and Generic Science Skills of Students

Ethnophysics Integrated CRT Learning

The use of CRT learning methods makes students curious and become more enthusiastic in the implementation of learning. Besides, practicum can also be done on this topic using law of physics existing in daily life and connecting students directly with their habits or culture through learning materials. The students in Reflective Journals write: ‘‘In my opinion, learning to use articles is incredibly fun for me because it is easier to remember and more effective" (Reflective Student journal, 30 April 2018). Another student writes: ‘‘In my opinion, learning to use articles is something new because we (students) gain insight on physics material which are related to Mandailing culture’’ (Reflective Student journal, 30 April 2018). One student comments: ‘‘In my opinion, practicals need to involve materials used in daily life, and learning physics has to involve the objects around us, as the materials used are also easy to find’’ (Reflective Student journal, 30 April 2018).

This is evident that a culture-based learning approach makes students particularly interested in learning, thus enhancing students’ motivation. Motivation and goals become the main factors for success in their academic activities. They study their cultural background and relate it to physical concepts contained in Ethnophysics articles. Furthermore, they are encouraged to generate questions, understand concepts, and obtain key ideas (Klingner & Vaughn, 1996; Calhoon, Al Otaiba, Greenberg, King, & Avalos, 2006; Sáenz, Fuchs, & Fuchs, 2005).

Based on the above findings, there are a few generalizations. First, that learning of physics is associated with students’ cultural background. Ethnophysics is the phenomenon that utilizes characteristics of CRT as learning phase and it involves mainly four aspects: collaborative teaching, responsive feedback, modeling, and instructional scaffolding. The aspect of collaborative teaching is a learning method integrated with CRT, where students learn from their collective experiences. The responsive feedback aspect is a strategy for incorporating students' responses in the form of culturally responsive feedback. The aspect of instructional scaffolding is a state when teachers ask questions about students’ cultural background through instructional support materials such as audio-visual media, maps, and stories). The last aspect of modeling is a critical component in effective learning where teachers use examples as models based on students’ cultural experiences. This subsection discusses each of these aspects in detail.

Collaborative learning methods strengthen students’ background knowledge, interdependence, sharing and collaboration, while enhancing their literacy motivation (Klingner & Vaughn, 1996; Klingner & Vaughn, 1999; O’Connor & Vadasy, 2011; Vaughn, et al., 2011). In collaborative-based instruction, the teacher gives a general introduction of the lesson, and eventually shares the learning assignments with students. However, all students learn about the same topic, but tasks vary according to their respective abilities. The teacher collectively organizes students into heterogeneous learning teams where they read and identify the assignment, discuss the topic with their group members, share individual knowledge and eventually complete the lesson.

Collaborative teaching can be integrated with Ethnophysics articles that are related to the traditions or daily lives of students. These articles sampled for this study include: "Traditional Mandailing Ceremony", "Marcungkil (Patok Lele) Traditional Game of Mandailing Origin", "Tor-tor of Traditional Art of Mandailing Tribe", "Gordang Sambilan as a Musical Instrument in Mandailing". The article on the “Mangupa Tradition of the Mandailing Tribe Ceremony” discusses the indigenous Mandailing tribe by using ingredients, namely chicken eggs. This Mangupa has a goal, which is to reincarnate someone. The law of physics says that eggs are put in a bowl filled with water. Good eggs will sink, while rotten eggs will stay afloat. The law is associated with the concept of static fluid, while the cultural base used is mangupa using chicken eggs. Similarly, the Marcungkil article on “Patok lele” discusses the traditional game of Mandailing origin which involves using two pieces of wood, one as a bat and the other as bait. The law of physics is linked with the concept of momentum and impulse, while the cultural base is marcungkil, using wooden sticks. The Tor-tor Traditional Art article discusses the Tor-tor art, which is always displayed with Gordang Sambilan. It has different names of which ‘Gordang Sambilan’ is the most popular, hudong-kudong, dua padua, dua patolu and enek-enek, played by five people through beating a membrane using a wood stick. The law of physics is linked with the concept of sound, while the cultural base used is the tor-tor dance using Gordang Sambilan. Lastly, the article on Gordang Sambilan Music Instrument in Mandailing discusses musical instruments in mandailing with the player of Gordang Sambilan, consisting of 11 musicians. Sarune is made of bamboo; it produces sound, has four air holes, and one inflatable space. The law of physics is linked with the concept of organ pipes, while the cultural base is Gordang Sambilan using Sarune.

The responsive feedback aspect is a strategy for incorporating students' responses, ideas, languages, and experiences into the feedback provided. In this culturally responsive feedback, they are expected to participate, respond, and have a new understanding of what they are learning (McIntyre & Hulan, 2013). During learning, students engage in the exchange of critical feedback, respond, and dialogue smoothly to give their opinions and respective thoughts (Jiménez & Gersten, 1999). This feedback is intended for students to give or exchange ideas about their experiences and respective cultures. It requires their understanding of articles adjusted to knowledge of their home culture in general. Articles are designed as a medium for students to develop their understanding. During this stage, the teacher directs their perception of questions, of which some respond and answer enthusiastically. The traditional response about their place of origin or parents was as follows: " My parents are from the Mandailing tribe, where the mangupa culture is regarded, and believed to reincarnate someone." Another student said that until the present, the mangupa tradition was carried out by his family but did not use egg ingredients, instead they used others such as porang-porang fish. One students commented: ‘‘I am a native of Mandailing. The culture here is the tradition of mangupa which uses chicken (manuk), chicken eggs (pira manuk) and leaf tips (bulung) in the required amount.” When asked, apart from these three ingredients, which other ingredients they used, the reply was: “porang-porang fish is a substitute’’ (Student interview, May 4, 2018). One teacher commented, “Students are generally enthusiastic about physics laws or material if they are related to their habits or daily life’’ (Teacher's note, May 4, 2018). These findings suggest that culture-based learning influences student enthusiasm in speaking on their culture, and they feel proud of their cultural background.

The aspect of modeling is a critical component in effective learning. Teachers are expected to give examples based on their cultural experience in this culture-based teaching. Additionally, students are involved in discussions, giving examples of their cultural backgrounds, language, and respect for other people's cultural diversity and everyday experiences (Jiménez & Gersten, 1999; Gerber, et al., 2004; Kamps, et al., 2007; Vaughn, et al., 2006). Physics learning integrated with Ethnophysics CRT is carried out using think pair share, discussion, and practicum, lecture, and debate approaches. It involves a cooperative method that aims to build positive interactions between students regardless of their cultural background. This method of learning stimulates creativity, enhances information, and teamwork. The teacher acts as a role model or a facilitator during the learning process, which is corroborated by the following comments in a reflective journal: ‘‘The role of the teacher is already good and attracts the attention of students, because they are not too focused on the formula. However, if the students do not understand, the teacher is always willing to repeat it' '(Reflective journal of Students, May 7, 2018). Another comment suggest: ‘‘The teacher plays a good role; provides information, explains and associates physics with the tradition of mandailing '(Reflective Student journal, May 7, 2018).

These statements about teacher’s role modeling signify that a teacher helps students understand the subject matter. The teacher's role is important in learning not only because it facilitates students, but acts because the teacher acts both as a consensus and mediator. In addition, some students also revealed that the teacher helped them understand certain concepts. One impact of the application of the modeling method is the emergence of soft social skills. Through group discussion activities, students develop an attitude of social awareness. Furthermore, through the Ethnophysical articles presented, students learn about their culture and society. This fact can be seen in the following note: ‘‘Learning methods and techniques regarding culture-based Ethnophysics articles were applied to enable students build interactions irrespective of their differences in opinion, to complete the assignment given by the teacher " (Note of an observer, May 11, 2018).

A practicum was carried out using materials that exist in the daily lives of students, such as a 5-inch diameter pipe surface covered with a balloon, tied with a rubber band and then beaten using pencils to produce a sound. With practical learning, students eventually recognize the sound, which helps them distinguish sounds of other materials. Thus, students share insights with those around them. Furthermore, students are taught to be more aware of the cultures in their society. one student comments: ‘‘I realize my culture is starting to fade in my daily life. However, due to the Ethnophysics articles, I have gained insight and knowledge on my own culture '(Student Interview, May 11, 2018). Contextually, students realize that knowing one's own culture is a learning process which enhances interactions with others.

This learning fosters the soft skills of patriotism, enabling them understand the diversity of their culture, be sensitive to cultural riches, and try to nurture it. One journal states: ‘‘The mangupa tradition is positive because of its many benefits, such as reincarnation, while the musical tradition of the gordang is either for welcoming guests or organizing a traditional party event in Mandailing. This tradition has to be preserved and developed '(Reflective journal, May 11, 2018). Based on the reflective journal, students respond positively to the traditions contained in the articles. Mangupa as a tradition of mandailing tribal ceremonies, according to them, has to be preserved in order not to disappear. Students’ attitude states that they respect the traditions of their ancestors and want to keep them alive.

The last aspect of instructional scaffolding occurs when students have difficulty regarding an assignment. Teachers and students equally contribute in enhancing a deeper understanding of the problems of cultural and linguistic backgrounds. The teacher proffers questions about the culture that students have and uses instructional support materials like audio-visual media, maps, and stories. This learning encourages students to work in groups, hence boosting cooperation (Jiménez & Gersten, 1999).

This is evident in the following statements made by a student: ‘‘I love to discuss and work within study groups because when I do not understand anything, another friend of mine can give advice and explain it, to enable me understand" (Reflective Student journal, May 7, 2018).

Conclusion

This study exemplified how learning of physics principles like static fluid material, momentum and impulses, sound, and organ pipeline can be leant through Culturally Responsive Teaching (CRT) Approach by integrating Ethnophysics with teaching. The CRT approach can be developed with the principles like collaborative teaching, responsive feedback, modeling, and instructional scaffolding. This study used the debating method, role-playing, and practicum with the help of Ethnophysics articles and by incorporating stories associated with students’ daily life. This learning fosters and provides an increase in the soft skills of students, including social awareness and patriotism.

From the data analyses, it can be concluded that: First, the average scores of the generic science skills in Cycle I gained 55, Cycle II obtained 59, Cycle III 64, and Cycle IV 66. Second, the average score of generic science skills of students for each indicator in cycle I gained 2.37, Cycle II gained 2.31 and Cycle III amounted to 2.79, while Cycle IV attained 2.90. Third, the N-Gain score of generic science skills obtained in cycles I and II amounted to 0.28 with low qualifications, in Cycle II and III,. It was 0.44 with moderate qualifications, and in III and IV, it was 0 and 53 with moderate qualifications. Lastly, an increase was observed in the generic science skills of students through Ethnophysics in Batak culture-based learning as indicated by the average scores and N-gain scores.

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