AL IBTIDA: JURNAL PENDIDIKAN GURU MI (2022) Vol 9 (2) : 382-391
DOI: http://dx.doi.org/ 10.24235/al.ibtida.snj.v9i2.10273

Al Ibtida: Jurnal Pendidikan Guru MI
ISSN: 2442-5133, e-ISSN: 2527-7227
Journal homepage: http://syekhnurjati.ac.id/jurnal/index.php/ibtida
Journal email: alibtida@syekhnurjati.ac.id

Changing the Concept of Prospective Primary Education Teachers through Ethnoscience-based Critical Thinking

Agus Mukti Wibowo*
*Department of Madrasah Ibtidaiyah Teacher Education, Faculty of Tarbiyah and Teacher Training, Universitas Islam Negeri Maulana Malik Ibrahim Malang, Indonesia.
E-mail: mukti@pgmi.uin-malang.ac.id

Received: April 20th, 2022. Accepted: October 22nd, 2022. Published: October 30th, 2022.

Abstract

A suitable environment as a learning resource can improve critical thinking skills. Increasing critical thinking skills will strengthen the concepts mastered or change the concepts if there is an error in understanding. The purpose of this study is to find out the change or shift of concepts through critical thinking of prospective teachers of primary school in ethnoscience-based learning. It is carried out using questionnaires and interviews to see the concept changes experienced by prospective primary school teachers through critical thinking in ethnoscience learning. The survey results and participant interviews show that the concept change in ethnoscience-based learning occurs because of an increase in critical thinking skills. This increase occurs because of relevant problems that critically encourage prospective primary school teachers to provide argumentation and analysis. The real problems that exist around us and are easy to find in everyday life are about the culture or the surrounding environment. A learning environment based on culture or local wisdom is one of the alternatives that can be used in science learning to increase concern for the environment and the surrounding culture.

Keywords: *ethnoscience, argumentation, critical thinking.*

Abstrak

Lingkungan, budaya, dan kearifan lokal menjadi inspirasi, imajinasi, dan kreativitas dalam belajar. Lingkungan yang cocok sebagai sumber belajar dapat meningkatkan keterampilan berpikir kritis. Meningkatkan kemampuan berpikir kritis akan memperkuat konsep yang dikuasai atau mengubah konsep jika terjadi kesalahan dalam pemahaman. Tujuan dari penelitian ini adalah untuk mengetahui perubahan atau pegeseran konsep melalui berpikir kritis dari calon guru madrasah ibtidaiyah/sekolah dasar dalam pembelajaran berbasis etnosains. Dilakukan dengan menggunakan kuesioner dan wawancara untuk melihat perubahan konsep yang dialami oleh calon guru madrasah ibtidaiyah/sekolah dasar melalui pemikiran kritis dalam pembelajaran etnosains. Hasil survei dan wawancara partisipan menunjukkan bahwa perubahan konsep pembelajaran berbasis etnosains terjadi karena adanya peningkatan kemampuan berpikir kritis. Peningkatan ini terjadi karena adanya permasalahan relevan yang secara kritis mendorong calon guru

madrasah ibtidaiyah/sekolah dasar untuk memberikan argumentasi dan analisis**.** Permasalahan nyata yang ada di sekitar kita dan mudah ditemui dalam kehidupan sehari-hari adalah tentang budaya atau lingkungan sekitar. Lingkungan belajar berbasis budaya atau kearifan lokal merupakan salah satu alternatif yang dapat digunakan dalam pembelajaran sains untuk meningkatkan kepedulian terhadap lingkungan dan budaya sekitar.

Kata kunci: *etnosains, argumentasi, berpikir kritis.*

INTRODUCTION

Science material is mainly related to the environment. The environment in science learning can be in the form of natural surroundings, culture, events, phenomena in the community, and local wisdom or traditional knowledge. Gondwe and Longnecker (2015) stated that there is a relationship between scientific knowledge and community culture in specific themes, especially those related to contextual facts. Cross-cultural instruction also has a relationship and influence in science classrooms.

As part of the learning environment, culture can be used for science learning or referred to as ethnos-based learning. Teachers' perceptions of culture or ethnoscience are essential in science learning (Alghamdi & Malekan, 2020). The interaction of students with the environment, including culture or local wisdom, can shape attitudes, behavior, skills, and understanding and build knowledge (Kiray & Simsek, 2021). Students' interactions with the environment in their daily lives and technology will increase their knowledge in science learning (Alghamdi & Malekan, 2020). Sholahuddin and Admoko (2021) also state that science learning innovation can be done by connecting materials based on local wisdom or relating to students' lives. This innovation will provide new knowledge and learning experiences for students. This shows that local knowledge and scientific knowledge impact science learning (Sotero et al., 2020). Therefore, Gloria and Edward (2016) suggest that teachers should not abandon local knowledge in science learning.

Difficulties in understanding concepts in science learning are caused by students having difficulty relating experiences from the surrounding environment as learning resources. According to Leggett (2017), the environment can be used as a source of imagination and creativity in learning. For example, community activities related to the transportation system for plants, by cutting trees or trunks to bear fruit quickly. This activity can certainly be used as material for discussion and dialogue in learning.

Zidny, Sjöström, and Eilks (2020) stated that it required an analysis of the use of local knowledge in science learning. Teachers should pay attention to the positive impact of local knowledge communication that has historical value (Reid O'Connor & Norton, 2020). The connection of local or cultural knowledge in learning will gain new knowledge (Sotero et al., 2020). Local knowledge can motivate students to give scientific arguments.

Students in science learning should be challenged about their cultural hegemony as an identity. This challenge is expected to generate knowledge based on the critical analysis provided by students, which will eventually lead to new understanding. Critical thinking is one of the 21st-century skills. Ethnoscience-based learning can be used to improve 21st-century skills (Nurcahyani et al., 2021).

Local knowledge or ethnoscience can be developed in science Click or tap here to enter text. (Hikmawati et al. 2021). The development of ethnoscience-based learning may

challenge students to provide critical analysis. Most students fail to provide critical analysis of events in the community. Critical analysis will form higher thinking on the problem or event at hand. Critical thinking and high-level thinking in dialogue or discussion in learning will make it easier for students to understand and build new knowledge (France, 2021). The relevance of the problem or event presented is essential in the learning process. One of the exciting events or problems is those that are close to the lives of students, for example, the surrounding culture or local wisdom, the relevance of science to religion (Erduran et al., 2019), science to culture (Sotero et al., 2020), or science to local community knowledge (Valderrama-Pérez, et al., 2015).

The availability of problems based on experience and relevant phenomena can support students' critical thinking skills. The availability of experience will affect the perception of concepts mastered by students (Zvoch et al., 2021). The availability of authentic experience can be used as a catalyst to trigger critical analysis, strengthen the concepts mastered or even change them. Concept changes can occur due to the dissatisfaction of students to meet the learning needs of the concepts that have been mastered (Thomas & Kirby, 2020). Concept changes or shifts can occur through conceptual errors or mistakes that can be used as learning catalysts (Tan Sisman & Aksu, 2016), cognitive and motivational involvement (Taasoobshirazi et al., 2016); active involvement in group discussions (McLure et al., 2020). Involvement in group discussions will lead to dialogue and critical thinking based on relevant sources of knowledge.

Implementing ethnoscience-based learning can improve critical thinking skills and knowledge (Sarwi et al., 2021). Several ethnoscience studies, including knowledge from culture, community habits, or local wisdom. Teachers should be able to facilitate students to improve their critical thinking skills. Students who experience an increase in critical thinking skills will have high-level analytical skills and even experience changes in understanding. According to Wilson (2018), critical thinking skills will change misunderstandings. This shows that critical thinking skills can change students' understanding.

The description above shows that there may be a link between local culture ethnoscience as experience, knowledge, and learning resources from the environment or the surrounding community with students' critical thinking skills. Research on ethnoscience and local knowledge has been widely carried out, for example, on students' local knowledge of fish migration, wind, fisherman refraction (Valderrama-Pérez et al., 2015), ethnic and cultural education models in practice, subjects and thematic in scientific projects writing (Baigabylov et al., 2013), the effectiveness of ethnoscience in improving scientific literacy and scientific character of students in elementary teacher education programs (Atmojo et al., 2019), an approach that is packaged in the form of an ethnoscience-based module (Sudarmin et al., 2017). The research above shows that ethnoscience learning can improve the quality of learning, and for that, it is necessary to see whether it is also able to change concepts through critical thinking.

Ethnoscience-based learning is an approach that can improve the understanding of concepts (Valderrama-Pérez et al., 2015). Ethnoscience learning can also provide a more meaningful learning experience (Sumarni, 2018). Ethnoscience learning can be combined with various strategies or other approaches, for example, with Problem Based Learning (S. Sudarmin et al., 2019), STEM (Sudarmin et al., 2019), literacy (Atmojo et al., 2019;

Nurcahyani et al., 2021; Sumarni, 2018) or character (Atmojo et al., 2019; Sudarmin & Sumarni, 2018)

The research above shows that ethnoscience can be used and influence learning. Further analysis is needed on ethnoscience in learning related to critical thinking skills. Critical thinking skills in ethnoscience-based learning are fundamental in science learning. So, culture-based learning (ethnoscience) is one study that is very likely to be explored (Erduran et al., 2019).

METHODS

The research was conducted using quantitative and qualitative approaches. A quantitative approach is carried out to determine the critical thinking skills of prospective primary education teachers about the plant transportation system based on events that occur in the community. To obtain the data, a survey was conducted. The survey is a questionnaire to see the trend of opinion and describe the question (Creswell & David Creswell, 2018). The questionnaire contains the perspective of prospective primary education teachers on ethnoscience and the ability to provide critical analysis. The questionnaire was compiled based on operational definitions in ethnoscience understanding scientific concepts. To see more about the changes in the concept that occurred, interviews were carried out. Interviews were conducted based on the survey results of prospective primary education teachers. Interviews are directed at answers used to compare respondents (Denzin &Lincoln, 2018).

The research sample was student teacher candidates in the Madrasah Ibtidaiyah Teacher Education study program. The sample in this study is prospective teachers who have taken courses in basic concepts of science and science learning. The sample was obtained voluntarily.

The data collection stage starts with conducting a survey on the understanding of ethnoscience. The questionnaire is compiled based on the operational definition of ethnoscience and understanding of the concept of science and distributed to the sample. The questionnaire is used to find out the response of prospective basic education teachers. Questionnaires are validated by experts who understand questionnaires and science learning. The results of the questionnaire become the basis for making questions in the interview. Interview questions are made to be directed at the answers used to compare respondents (Denzin & Lincon, 2018). Interviews are structured to obtain data on and understand ethnoscience and concept changes.

The research instrument consists of a questionnaire and an interview. The questionnaire was filled in based on the knowledge and understanding possessed. The questionnaire data was then confirmed through interviews. The variables in this study were the perception of the ethnoscience understanding of the prospective primary education teacher and scientific argumentation ability. Interviews were conducted based on data from questionnaires to find out more about understanding the concepts of prospective primary education teachers.

Data analysis techniques start from the presentation of questionnaire results. The results of the questionnaire were tabulated about the perspective of prospective teachers on ethnoscience. Based on these data, interviews were conducted with the sample to find out more about the understanding and changes in concepts that occurred. Transcription of interview results by recording important parts of the interview results related to

understanding the concept of science, ethnoscience, changes or shifts in the concept of science, as well as the ability to argue and think critically. Tabulation of interview results of general science understanding, ethnoscience understanding, scientific argumentation, critical thinking, and the number of students who experience changes or shifts in science concepts. Identifying understanding is used to see changes or shifts in concepts experienced by prospective primary education teachers.

RESULTS AND DISCUSSION

The ethnoscience data in this study was obtained from an online questionnaire instrument via a google form. Based on questionnaire data shows that prospective primary education teachers have a positive perspective on ethnoscience-based learning and give positive opinions on ethnoscience related to local wisdom in science learning. Data on the perspective of prospective education teachers on ethnoscience learning are shown in Table 1.

Table 1. Primary School Teacher Candidate Perspective on Ethnoscience learning

Aspects	% Very Agree	% Agree	% Do Not Agree
The relationship of science to everyday life	77,2	22,8	0,0
Support experience and knowledge in life to understand science	48,5	50,7	0,7
The attractiveness of learning science related to culture/culture/or local wisdom	35,9	64,1	0,0
Ease of understanding science related to local wisdom	28,3	69,6	22,2
The level of belief in the relevance of habits or activities carried out by the community related to science	26,1	72,8	1,1

Table 1. shows that most give a positive response to ethnoscience learning. This shows that aspiring primary education teachers realize that ethnoscience-based learning is appropriate for use in science learning. Almost all prospective teachers respond well to the relationship between science and daily life culture and local wisdom and can support the understanding of science. Most prospective teachers also believe that ethnoscience-based learning is relevant to habits or activities carried out by the community related to science.

When interviews are conducted related to the relationship between science and local wisdom, they have difficulty understanding it. For example, the arguments of prospective primary education teachers about understanding the relationship between the concept of science and everyday life include xylem and phloem based on the cutting of mango tree trunks. Some primary education teacher candidates do not even know the benefits of these activities. This shows that prospective teachers have failed to provide arguments from the events presented. This failure may be related to a lack of critical thinking skills (BouJaoude, 2016). Kabataş Memiş and Çakan Akkaş (2020) also state that critical thinking skills are necessary for 21st-century learning that can be applied throughout their lives. The 21st-century skills framework recommends that educational institutions develop critical thinking skills (Koh et al., 2015).

Some of the arguments given by prospective primary education teachers were wrong. For example, "the incident was a way of grafting." This statement causes errors in understanding the events or problems encountered with the studied concept. Errors in understanding the concepts mastered may cause inappropriate arguments. If it occurs consistently, this error will lead to a conceptual error.

One alternative that can be used to overcome the problems mentioned above is ethnoscience-based learning. Ethnoscience is knowledge obtained from one's language and culture that can be verified and innovated in science-based learning in the classroom. Ethnoscience is a learning approach that elevates culture or local wisdom into objects of science learning (Kiray & Simsek, 2021). Proper scientific knowledge consists of all knowledge related to the facts of society. This pattern of knowledge development is passed on continuously between generations, is not structured and systematic in the curriculum, is informal, and is general knowledge of people's perceptions of certain natural phenomena (Zidny et al., 2020).

Some prospective teachers experienced a change in their understanding of ethnoscience-based learning. Changes in understanding may also be accompanied by changes in the level of thinking of prospective primary education teachers. Changes in argumentation that occur may also be influenced by the active involvement of prospective primary education teachers in dialogue and discussion (McLure et al., 2020), the availability of new experiences (Zvoch et al., 2021) or due to student dissatisfaction with meeting learning needs for concepts that have been mastered (Thomas & Kirby, 2020).

Relevant learning experiences and active involvement in learning will help students' thinking skills (BouJaoude, 2016). Active involvement in learning can build critical thinking skills through scientific reasons or arguments against phenomena or events in everyday life. The opportunity to develop critical thinking will allow students to be productive in learning activities (BouJaoude, 2016). Learning activities through discussions and scientific arguments can bring up critical ideas about phenomena in the environment (Memiş & Akkaş, 2020), including culture, community habits, or knowledge in everyday life. The emergence of critical analysis and scientific argumentation is one indicator of critical thinking skills.

Some examples of scientific arguments that demonstrate critical thinking skills include: "Disconnection of the phloem pathway causes the interruption of the food delivery route." Food is the result of photosynthesis from plants sent through the phloem pathway. If the phloem is cut off, the food will be stored in the form of food reserves. The form of a food reserve, among others, is fruit. An example of the reason or argument given is: "this wound is intended so that plant nutrients are not distributed to the roots so that they accumulate and will become food reserves." The meaning of nutrition here is the result of plant photosynthesis that should be sent to all parts. Disruption of the phloem pathway causes nutrients not to be sent and stored in the form of food reserves.

Some of the arguments above show that there is starting to be critical thinking of prospective elementary education teachers towards the events that have occurred. They try to give reasons critically by relating them to the concepts they have mastered. There are even some that can provide other relevant examples. The mission of learning critical thinking, according to Kwangmuang et al. (2021), includes: enabling students to give other examples and convey concepts to others, providing meaning that allows students to identify

similarities and classify, considering existing data and facts, practicing the ability to argue, practicing making conclusions, hypotheses, and predictions, making assumptions based on problems.

Changes in the concept of each student's perspective can provide insight into learning (McLure et al., 2020). Conceptual change in science class refers to developing the authenticity of conceptions accurately and correctly (Zvoch et al., 2021). The accuracy of the conception can be known through the critical thinking skills of students. Students can change or shift concepts because of a new scientific understanding. Changes that occur in each student will be different. Identifying patterns of thinking change is very important (Tekkumru-Kisa et al., 2019). Sufficient scientific reasons must accompany changes in understanding. Teachers have an essential role in facilitating this change by coordinating discussions or dialogues that allow students to provide critical analysis.

Concept changes can occur through effective feedback related to theoretical concepts (Asterhan & Dotan, 2018). Due to misconceptions, changes in the conception of science in students can be changed through the provision of experience (Zvoch et al., 2021). Conceptual changes can also occur due to the dissatisfaction of students to meet the learning needs of the concepts that have been mastered (Thomas & Kirby, 2020).

According to Heyd-Metzuyanim and Schwarz (2017), interaction productivity in concept change can be seen from three criteria: (1) availability of alternative discourses (proportional vs additive), (2asted) resistance of material/correctional institutions, and (3) students' position to make meta-discursive shifts. Students can obtain the availability of alternative discourses from experience and everyday knowledge, for example, knowledge from the community, culture, and local wisdom. Learning based on experience in the environment or surrounding community makes students state the knowledge they already have with existing facts and knowledge (cognitive conflict). This follows the opinion of Frappart and Frède (2016) that informal teaching can cause some students to question their prior knowledge and misconceptions and actively discuss arguments with friends/groups, thereby promoting cognitive conflict and conceptual change.

Changes or shifts in concepts can occur through: critical thinking through inquiry-based instructional practices (Zvoch et al., 2021), conceptual errors and errors that can be used as learning catalysts (Tan Sisman & Aksu, 2016), cognitive engagement and motivation (Taasoobshirazi et al., 2016), active involvement in group discussions (McLure et al., 2020). Critical thinking in learning requires the active involvement of students in learning. The critical attitude of students shows dissatisfaction with the existing concept. This will result in students trying to find and provide scientific arguments or reasons for the problems at hand.

Science learning is expected to be relevant to society’s social problems. Following the proposal, the learning approach involves elements of life, finding solutions to problems based on the local potential that exists in the community (Sotero et al., 2020). Science learning should also be linked to the context of local wisdom. Local wisdom is a motivational stimulus for students to form an understanding. Thus, prospective teachers are expected to understand the concept of local wisdom to be linked to science learning.

CONCLUSION

Misunderstandings in science learning may be due to a lack of critical thinking skills. Errors that occur consistently will lead to conceptual errors. A change in understanding of the error or inaccuracy is required. Ethnoscience-based learning is one approach that can be used to make conceptual changes. Ethnoscience-based learning presents local wisdom, cultural events, or phenomena that occur in society. Ethnoscience can be used as one of the alternatives in science learning to improve critical thinking skills. In addition, ethnoscience-based learning can also increase concern for the wisdom of the venue because it is based on cultural and environmental problems. The relevance of the events, phenomena, and problems presented may give a different perception to change understanding. Changes in understanding the concepts mastered can be seen through the ability to provide critical analysis and scientific arguments from these events or phenomena.

REFERENCES

Alghamdi, A. K. H., & Malekan, M. (2020). Saudi science teachers' perceptions of the cultural factors influencing elementary students' science learning. *Cultural Studies of Science Education*, *15*(4), 1143-1167. DOI: 10.1007/s11422-019-09960-9.

Asterhan, C. S., & Dotan, A. (2018). Feedback that corrects and contrasts students' erroneous solutions with expert ones improves expository instruction for conceptual change. *Instructional Science*, *46*(3), 337-355. DOI: 10.1007/s11251-017-9441-1.

Atmojo, S. E., Kurniawati, W., & Muhtarom, T. (2019, November). Science learning integrated Ethnoscience to increase scientific literacy and scientific character. In *Journal of Physics: Conference Series* (Vol. 1254, No. 1, p. 012033). IOP Publishing.

Baigabylov, N. O., Beisembaev, A. R., & Baigusheva, K. M. (2013). some issues of ethno-cultural education in modern Kazakhstan. *Procedia-Social and Behavioral Sciences*, *89*, 409-412. DOI: 10.1016/j.sbspro.2013.08.868.

BouJaoude, S. (2016). Thinking Collaboratively: Learning in a Community of Inquiry. *International Review of Education*, *62*(1), 123–25. DOI: 10.1007/s11159-016-9538-9.

Creswell, J. W., & Creswell, J. D. (20187). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Denzin, N. K., & Lincoln, Y. S. (2018). The Sage handbook of qualitative research. *London, Stage Publication*.

Erduran, S., Guilfoyle, L., Park, W., Chan, J., & Fancourt, N. (2019). Argumentation and interdisciplinarity: reflections from the Oxford Argumentation in Religion and Science Project. *Disciplinary and Interdisciplinary Science Education Research*, *1*(1), 1-10. DOI: 10.1186/s43031-019-0006-9.

France, A. (2021). Teachers using dialogue to support science learning in the primary classroom. *Research in Science Education*, *51*(3), 845-859. DOI: 10.1007/s11165-019-09863-3

Frappart, S., & Frède, V. (2016). Conceptual change about outer space: how does informal training combined with formal teaching affect seventh graders' understanding of gravitation?. *European journal of psychology of education*, *31*(4), 515-535. DOI: 10.1007/s10212-015-0275-4.

Gondwe, M., & Longnecker, N. (2015). Scientific and cultural knowledge in intercultural science education: Student perceptions of common ground. *Research in Science Education*, *45*(1), 117-147. DOI: 10.1007/s11165-014-9416-z.

Heyd-Metzuyanim, E., & Schwarz, B. B. (2017). Conceptual change within dyadic interactions: the dance of conceptual and material agency. *Instructional Science*, *45*(5), 645-677. DOI: 10.1007/s11251-017-9419-z.

Hikmawati, Suastra, I. W., & Pujani, N. M. (2021, February). Local wisdom in Lombok island with the potential of ethnoscience for the development of learning models in junior high school. In *Journal of Physics: Conference Series* (Vol. 1816, No. 1, p. 012105). IOP Publishing.

Kabataş Memiş, E., & Çakan Akkaş, B. N. (2020). Developing critical thinking skills in the thinking-discussion-writing cycle: the argumentation-based inquiry approach. *Asia Pacific Education Review*, *21*(3), 441-453.

Kiray, S. A., & Simsek, S. (2021). Determination and evaluation of the science teacher candidates' misconceptions about density by using four-tier diagnostic test. *International Journal of Science and Mathematics Education*, *19*(5), 935-955. DOI: 10.1007/s10763-020-10087-5.

Koh, J. H. L., Chai, C. S., Benjamin, W., & Hong, H. Y. (2015). Technological pedagogical content knowledge (TPACK) and design thinking: A framework to support ICT lesson design for 21st century learning. *The Asia-Pacific Education Researcher*, *24*(3), 535-543. DOI: 10.1007/s40299-015-0237-2.

Kwangmuang, P., Jarutkamolpong, S., Sangboonraung, W., & Daungtod, S. (2021). The development of learning innovation to enhance higher order thinking skills for students in Thailand junior high schools. *Heliyon*, *7*(6), e07309.

Leggett, N. (2017). Early childhood creativity: Challenging educators in their role to intentionally develop creative thinking in children. *Early Childhood Education Journal*, *45*(6), 845-853. DOI: 10.1007/s10643-016-0836-4.

McLure, F., Won, M., & Treagust, D. F. (2020). 'Even though it might take me a while, in the end, I understand it': a longitudinal case study of interactions between a conceptual change strategy and student motivation, interest and confidence. *Disciplinary and Interdisciplinary Science Education Research*, *2*(1), 1-17. DOI: 10.1186/s43031-020-00027-2.

Nurcahyani, D., Rahmayanti, H., Ichsan, I. Z., & Rahman, M. M. (2021, February). Ethnoscience learning on science literacy of physics material to support environment: A meta-analysis research. In *Journal of Physics: Conference Series* (Vol. 1796, No. 1, p. 012094). IOP Publishing.

Ramnarain, U. D., & Ramaila, S. (2016). The achievement goals orientation of South African first year university physics students. *International Journal of Science and Mathematics Education*, *14*(1), 81-105. DOI: 10.1007/s10763-015-9642-5.

Reid O'Connor, B., & Norton, S. (2020). Supporting indigenous primary students' success in problem-solving: Learning from Newman interviews. *Mathematics Education Research Journal*, 1-24. DOI: 10.1007/s13394-020-00345-8.

Sarwi, S., Nisa, G., & Subali, B. (2021, June). An analysis of critical thinking skill and interpersonal intelligence in the development of ethnoscience-based teaching material salt production. In *Journal of Physics: Conference Series* (Vol. 1918, No. 5, p. 052060). IOP Publishing.

Sholahuddin, M. I., & Admoko, S. (2021). Exploration of physics concepts based on local wisdom kolecer traditional games. *PENDIPA Journal of Science Education*, *5*(1), 70-78. DOI: 10.33369/pendipa.5.1.70-78.

Sotero, M. C., Alves, Â. G. C., Arandas, J. K. G., & Medeiros, M. F. T. (2020). Local and scientific knowledge in the school context: characterization and content of published works. *Journal of Ethnobiology and Ethnomedicine*, *16*(1), 1-28. DOI: 10.1186/s13002-020-00373-5.

Sudarmin & Sumarni, W. (2018, April). Increasing character value and conservation behavior through integrated ethnoscience chemistry in chemistry learning: A Case Study in The Department of Science Universitas Negeri Semarang. In *IOP Conference Series: Materials Science and Engineering* (Vol. 349, No. 1, p. 012061). IOP Publishing.

Sudarmin, Febu, R., Nuswowati, M., & Sumarni, W. (2017, March). Development of Ethnoscience Approach in The Module Theme Substance Additives to Improve the Cognitive Learning Outcome and Student's entrepreneurship. In *Journal of Physics: Conference Series* (Vol. 824, No. 1, p. 012024). IOP Publishing.

Sudarmin, S., Zahro, L., Pujiastuti, S. E., Asyhar, R., Zaenuri, Z., & Rosita, A. (2019). The Development of PBL-Based Worksheets Integrated with Green Chemistry and Ethnoscience to Improve Studentsâ€™ Thinking Skills. *Jurnal Pendidikan IPA Indonesia*, *8*(4), 492-499. DOI: 10.15294/jpii.v8i4.17546.

Sudarmin, Sumarni, W., & Mursiti, S. (2019, October). The learning models of essential oil with science technology engineering mathematic (STEM) approach integrated ethnoscience. In *Journal of Physics: Conference Series* (Vol. 1321, No. 3, p. 032058). IOP Publishing.

Sumarni, W. (2018). The Influence of Ethnoscience-Based Learning on Chemistry to the Chemistryâ€™ s Literacy Rate of the Prospective Teachers. *Unnes Science Education Journal*, *7*(2).

Taasoobshirazi, G., Heddy, B., Bailey, M., & Farley, J. (2016). A multivariate model of conceptual change. *Instructional Science*, *44*(2), 125-145. DOI: 10.1007/s11251-016-9372-2.

Tan Sisman, G., & Aksu, M. (2016). A study on sixth grade students' misconceptions and errors in spatial measurement: Length, area, and volume. *International Journal of Science and Mathematics Education*, *14*(7), 1293-1319.

Tekkumru-Kisa, M., Schunn, C., Stein, M. K., & Reynolds, B. (2019). Change in thinking demands for students across the phases of a science task: An exploratory study. *Research in Science Education*, *49*(3), 859-883. DOI: 10.1007/s11165-017-9645-z.

Thomas, C. L., & Kirby, L. A. (2020). Situational interest helps correct misconceptions: An investigation of conceptual change in university students. *Instructional Science*, *48*(3), 223-241. DOI: 10.1007/s11251-020-09509-2.

Valderrama-Pérez, D. F., Andrade, A. M., & El-Hani, C. N. (2015). Dialogue between scientific and traditional knowledge in the science classroom: development study of a teaching sequence in a school in Taganga (Magdalena, Colombia). *Procedia-Social and Behavioral Sciences*, *167*, 217-222. DOI: 10.1016/j.sbspro.2014.12.665.

Wilson, J. A. (2018). Reducing pseudoscientific and paranormal beliefs in university students through a course in science and critical thinking. *Science & Education*, *27*(1), 183-210. DOI: 10.1007/s11191-018-9956-0.

Zidny, R., Sjöström, J., & Eilks, I. (2020). A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability. *Science & Education*, *29*(1), 145-185. DOI: 10.1007/s11191-019-00100-x.

Zvoch, K., Holveck, S., & Porter, L. (2021). Teaching for conceptual change in a density unit provided to seventh graders: A comparison of teacher-and student-centered approaches. *Research in Science Education*, *51*(5), 1395-1421. DOI: 10.1007/s11165-019-09907-8.