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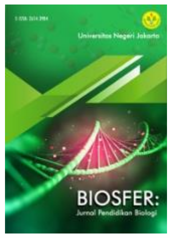

Integration of ethnoscience in problem-based learning to improve contextuality and meaning of biology learning

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A B S T R A C T

Meaningful learning can be carried out by adapting learning to local culture and traditions. Ethnoscience is a set of knowledge identified in a community and can be used as the learning base to create contextual and meaningful learning for students. This study aims to find more information about ethnoscience-based biology learning. The research method used was a literature study. The literature used mainly discusses ethnoscience, ethnoscience learning, and learning methods. The instrument used in this study was a summary table of all related articles, following the summary table made by Cronin et al. (2008). This research produces a new conceptual framework which is a synergy between ethnoscience and problem-based learning. This research also generates six procedures for designing ethnoscience-based learning and five steps to integrate ethnoscience into Problem-based Learning. The integration of ethnoscience in problem-based learning can increase the contextuality and meaning of biology learning and can be applied to maintain local culture. This study recommends the use of procedures resulted from this study to design ethnoscience-based learning and integrate ethnoscience learning into Problem-Based Learning.

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INTRODUCTION

Indonesia has a vast natural uniqueness. Uniqueness nurtured by each region will create distinctiveness in both cultures and traditions of a community. Besides, each ethnicity develops in accordance with local uniqueness and the availability of natural and cultural resources (Suryadarma, 2017). Local uniqueness will affect how a community fulfills its basic needs. Each ethnicity has cultural distinctiveness. Furthermore, each student is a part of an ethnicity and thereby establishing a life experience in accordance with it. Education has a role that is embedding knowledge and practical experiences in a scientific process, navigating learning processes culturally.The field of biology is well suited for this purpose.Research on the role of biology in various indigenous activities based on local wisdom has been widely researched, for example, the use of plants for traditional ceremonies, the use of plants as herbal medicine, and other studies (Haryadi, et al., 2019).

Each region in Indonesia has a different culture and tradition. The significance of learning can only be developed if learning activities are adjusted to the culture and tradition applicable. This local characteristic diversity can be deemed as a meaningful context in the learning process. Based on the diversity, Sudarmin (2015) states that the currently recommended scientific approach to education in Indonesia is ethnoscience.Ethnoscienceis defined as a set of knowledge owned by a community/people acquired using a certain method and procedure constituting a part of the community's tradition and its "truth" can be empirically assessed (Sudarmin, 2015). The relevance of ethnoscience to education is as a bridge through which children from various cultural backgrounds can lead to modern science(Abonyi, 2003). Also, ethnoscience pertains to cultural knowledge. It is known that cultural knowledge converted into science can enrich learning materials (Kidman et al., 2013; Dwianto et al., 2017). Furthermore, besides making learning more meaningful, ethnoscience-based learning can also maintain Indonesian cultures.Meaningful learning can improved student learning achievement in any aspect because they can comprehend the learning material well(Usman et al., 2019).

Essentially, learning is a process of interplay between students and the environment, students and students, students and learning sources, or students with teachers. Learning is considered meaningful if the materials learned is coherent with what has been learned and found by students in the environment. Ausubel (1963) believes that learning must be meaningful for students. Regarding this meaningful learning, we can refer to the theory of constructivism by Vygotsky. This theory clarifies that students can obtain learning significance by thinking and interplaying with the social context. Piaget, in his Piagetian Psychological Constructivism theory, developed Vygotsky's theory. He claims that everyone creates new significance and apprehension based on an interaction between what is known, owned, and believed and the phenomenon, idea, or information learned anew. In conclusion, the materials learned should relate to what has been known, owned, and believed by learners, as well as their social context.Correlation between learning topics and daily activities around their environment as learning sources integrated with local wisdom can improve the contextuality of learning(Pamungkas et al., 2017).

Ethnoscience learning has the suitability to increase the contextuality and meaningfulness of biology learning. Various studies on ethnoscience-based learning have shown satisfactory results. Science process skills in secondary school biology students were better acquired using ethnoscience strategy (Ibe & Nwosu, 2017), also ethnoscience instruction can promote learners' attitude to science(Fasasi, 2017a). Students' scientific literacy (in terms of content, competence, context, and attitudes) can be increased through the application of ethnoscience pedagogy in chemistry learning (Dewi et al., 2019).Unfortunately, the existing ethnoscience learning literature show ore on the results of the application of ethnoscience learning, it has not explained in detail how the learning sequence is designed.

Problem-based Learning (PBL)is one of the learning models that can be applied in biology learning. PBL is a pedagogical approach that allows students to learn while actively engaging with contextual and meaningful problems, and form self-directed learning habits (Yew & Goh, 2016; Gündüz et al., 2016). Ethnoscience combined with PBL will provide synergy so that the contextuality and meaning of learning will increase. Existing ethnoscience based learning research has not integrated ethnoscience into PBL. Guidelines on how to integrate ethnoscience learning into PBL need to be developed to make it easier for teachers to improve the contextuality and meaning of learning.

The novelty of this research is to provide knowledge about how the steps to structure ethnoscience learning and how to integrate it with PBL. Guidelines in designing ethnoscience-based biology learning and integrating it with PBL needs to be compiled to make it easier for teachers to organize ethnoscience-based learning, in any area, and any ethnic background. According to that problem, this research answers the three following research problems: 1) Integrated into PBL, how does ethnoscience improve the contextuality and the meaning of biology learning?, 2) How to design ethnoscience based learning?, and 3) How can we integrate ethnoscience in Problem-based Learning (PBL) in biology learning?

METHODS

Research Design

This research was conducted with literature review methodfollow Cronin's theory (Cronin et al., 2008). A literature review is a survey of scientific articles, books, and other sources relevant to a particular issue, field of research, or theory, and as such, provides descriptions, summaries, and critical evaluations of those works (Cronin et al., 2008; Ramdhani, et al., 2014).By integrating the findings and perspectives of many empirical findings, literature reviews can answer research questions with strengths that a single study does not have (Snyder, 2019).

Instrument

The instrument used in this study is a summary table of all related articles, following the summary table made by Cronin, et al. (2008), presented in Table 1. Articles are divided into 3 groups, namely primary sources, secondary sources-reviews, and non-research literature.

Tabel 1.
Summary of article information reviewed

Primary sources	**Secondary sources-review**	**Non-research literature**
Title:	Title:	Title:
Author and year:	Author and year:	Author and year:
Journal (full reference):	Journal (full reference):	Journal (full reference):
Purpose of study:	Review question/purpose:	Purpose of the paper:
Type of study:	Key definitions:	Credibility:
Setting:	Review boundaries:	Quality:
Data collection method:	Appraisal criteria:	Content:
Major findings:	Synthesis of studies:	Coherence:
Recommendations:	Summary/Conclusion:	Recommendations:
Key thoughts/comments, e.g strengths/weakness:	Key thoughts/comments, e.g strengths/weakness:	Key thoughts/comments, e.g strengths/weakness:

Source: Cronin, et al. (2008)

All literature sources compiled in this review article were selected based on certain criteria. Primary sources were selected from reputable journals and doctoral thesis. Secondary sources come from journals with article review type. Non-research literature in this study is a book. All sources of articles (journals, doctoral thesis, and books) selected were those related to ethnoscience, ethnoscience-based learning, PBL, and biology learning strategies. Because there are still few literature sources related to ethnoscience and ethnoscience-based learning, there is no limit to the literature year. Journals come from national and international with a good reputation. Meanwhile, the criteria for book selection are that have an ISBN, with the author and publisher having a good reputation.The end step of appraisal is to write a short summary of each article and can include key thoughts, comments, strengths, and also weaknesses of the publication. It should be written in the author's own words (Cronin, et al., 2008).

Procedure

The procedure carried out in the literature review follows foursteps (Cronin et al., 2008; Ramdhani, et al., 2014): 1) Choosing a review topic, 2)Searching and selecting appropriate articles, 3) Analyzing and synthesizing the literature, and 4) Organizing the review on the writing. . The topic chosen in this review article was the integration of ethnoscience into problem-based learning. This topic was chosen because of the lack of articles that describe detailed steps on how to organize ethnoscience learning, and how ethnoscience learning is integrated into PBL.For this topic, we found 22 relevant and credible literature to be analyzed. Literature is sourced from journal articles, seminar proceedings, and books. Literature that has been successfully selected is then broken down, sorted into groups. The groups used are literature on ethnoscience, indigenous knowledge, and problem-based learning in biology. The entire article was synthesized to find relationships and answer problem formulations.Writing the results of the review begins with a discussion of ethnoscience learning, then on the steps needed to integrate ethnoscience into problem-based biology learning.The research procedure is illustrated in Figure 1.

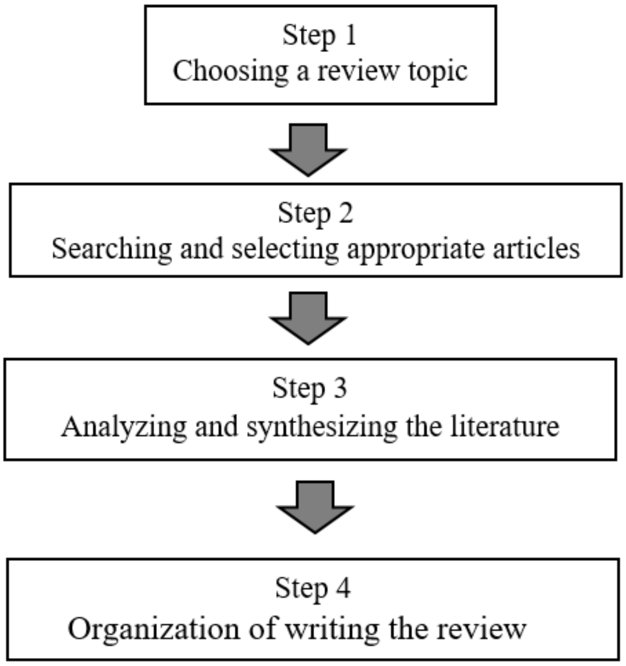

Figure 1. Research Procedure

Data Analysis Techniques

The data analysis was carried out qualitatively by grouping the entire literature into groups, then reviewing the contents of each article and making a synthesis. The literature that has been compiled is divided into five themes, namely ethnoscience, ethnoscience-based learning, PBL, biology learning methods and strategies, and the contextuality and meaning of biology learning. Qualitative analysis was conducted to answer research questions. Each source is reviewed, summarized, and synthesized. The result of the synthesis is a new conceptual framework used to answer research questions.

RESULTS AND DISCUSSION

Based on the results of the literature review compiled, the following descriptions are the results of the analysis and synthesis of the entire literature. The results of the synthesis are divided into four discussion sections, namely; Ethnoscience, Ethnoscience in Learning, How to Design Ethnoscience-based Learning, and Integrating Ethnoscience in the Model of Problem-based Learning (PBL) in Biology Learning. Each part is a continuous aggregate, for example, the first (ethnoscience in learning) and second (ethnoscience in learning) discussion will be the basis for building the concept in the third discussion (How to Design Ethnoscience-based Learning).

Ethnoscience

People have knowledge in regard to life. They do anything proper and they do not propose questions of why they do it. It is believed that humans are blessed with intuitions that help them adjust to nature and the environment where they live. Besides, the community has innate knowledge as the result of adaptation to the uniqueness of nature on where they depend on their life. In its relevance to the knowledge, ethnoscience, by definition, is a set of knowledge possessed by a community/people or ethnic group (Sudarmin, 2015; Parmin et al., 2017). Aligned with the argument, Abonyi (1999) describes ethnoscience as knowledge related to local perceptions, practices, skills, ideas, and cosmology which act as the basis of the socio-economic development process. Furthermore, each region nurtures different myths. Ethnoscience develops from myths, supernatural, mystical reality, and acculturation taking place in an environment (Ugwuanyi, 2015). Ethnoscience maintains a relationship with students as a part of the community. It refers to the materials, ideas, beliefs, and technology of a community or environment, and the materials, ideas, beliefs, and technology are derived from students' past and present cultural traditions and practices (Okwara & Upu, 2017).

Ethnoscience depicts the result of the interaction between a subject and its life and social and cultural environment. In line with the opinion, Rist&Dahdouh-Guebas (2006) confirm that ethnoscience is an integration of diverse social disciplines (anthropology, philosophy, sociology, psychology, and history) with natural sciences (biology, ecology, agriculture, fishery, astronomy, climatology, and medical). As such, ethnoscience covers a vast array of disciplines and can be studied from a holistic perspective.

Ethnoscience and local knowledge or indigenous knowledge of a community are inseparable. Carothers et al. (2014) convey that the Indigenous Knowledge (IK) system can be described and comprehended using an approach oriented to collaborative practices, case studies, and research. In other words, implementing ethnoscience in a community or ethnicity can be conducted by integrating into their life practices or making a case study or collaborative research.

Ethnoscience is pivotal in ecosystem sustainability. Thornton & Scheer (2012) explain that to maintain and ensure the sustainability of the maritime ecosystem, collaborative engagement of local knowledge (indigenous knowledge) with modern science is needed. Although local knowledge appears non-scientific, it is considered an effective means of conservation. In many cases, indigenous knowledge is considered non-scientific by even indigenous people. Many important themes; such as the relationship between biotic and abiotic systems and the concept of how the system of life functions; the Western scientific traditions, and sophisticated contemporary ideas relate physics and biology in a non-intuitive manner (Pierotti ,2016). Meanwhile, the preeminence of indigenous knowledge as the very heart of ethnoscience can also be identified in Rist & Dahdouh-Guebas (2006)which mentions that different from scientific knowledge, local wisdom (indigenous knowledge) is holistic, functional, and adaptive to social and natural changes in nature. Furthermore, it is inherited by generations.

Nevertheless, often, biological diversity is separated from the cultural one, while in relation to ethnoscience, it determines the cultural diversity of a community. Essentially, a shift in people's paradigms is required to alter how they perceive global diversity, where biological and cultural diversity is supposed to walk side by side (Pilgrim et al., 2009). For instance, we find that flora and fauna diversity in the mountain is different from that on the beach. In response to this difference, a community's daily life practices will be adjusted to the biological condition of the area where they live in and hence the local or indigenous knowledge generated will be different as well.

Warrren et al. (1995) propose that a study of ethnoscience should at least include five major aspects which are: 1) (Pre)historic assessment regarding nature and cultures made by a certain community, 2) Culture-specific or culture-bound references of several terms, 3) A holistic approach to the introduction of various subsystems of knowledge and technology in some sectors, such as medical, agricultural, educational, and others, 4) Dynamic evaluation of cultural concept in terms of a configuration system of Western and non-Western knowledge which interact with each other, and 5) Comparative orientation (non-normative orientation, inspired by Western and non-Western orientations) to the development process of a certain region or culture.

Ethnoscience in Learning

In regard to education, ethnoscience acts as a bridge which allows students from different cultural background access modern knowledge (Abonyi, 2003). Several studies have shown that ethnoscience-based learning can improve students' abilities; scientific skills are better acquired using ethnoscience strategy (Ibe & Nwosu, 2017), also students' cognitive abilities have increased(Fasasi, 2017b).The research recommends stakeholders, especially lecturers, use information, engage students in a teaching-learning process actively, and use a suitable ethnocational paradigm. Besides enhancing students' understanding of the concept, ethnoscience-based learning can build their characters. The most relevant character built is concerns about nature. A chemical learning integrated with ethnoscience has raised an improvement in students' characters and behaviors (Sudarmin & Sumarni, 2018).

Introducing sustainable innovation for science and technology education in an ethnoscience-based classroom, Abonyi et al. (2014) propose the following stages: 1) Designing a hybrid network of the concept with a suitable integration, 2) Scientific programs implemented in schools/campuses should be designed to ensure the hybridization of cross-cultural concepts and processes. This requires the establishment of a relationship with international institutions regarding local knowledge. The institutions are the Center of Indigenous Knowledge for Agriculture and Rural Development (CIKARD) the Leiden Ethnosystem and Development Programme (LEAD), the Center for International Research and Advisory Network (CIRAN), the Nigerian Institute of Social and Economic Research (NISER), the Regional Programme for the Promotion of Indigenous Knowledge in Asia (REPPIKA), and others. The relationship between educational institutions/schools/campuses and the international institutions will ensure the information flow, documentation of cross-cultural indigenous knowledge, and research on the hybridization of local knowledge using another advanced scientific knowledge. As such, scientific classes will be a technology incubator and pioneer of innovations for sustainable development, 3) Developing a learning module by an indigenous concept, practice, and product, 4) Using the outcome of global networking and the relationship between local and international institutions regarding local knowledge, a new learning module is designed. With this module, a more integrated knowledge system will be formed. This will contribute to the scientific learning group which is often isolated by institutional and sectoral barriers, 5) Making a scientific classroom which focuses on local entrepreneurship and aims at improvement and internalization.Our further concern is how to integrate this technology into a formal scientific class to improve and internationalize the class. This concern can be resolved by establishing the center for indigenous knowledge incubation in schools using assistance provided by several institutions regarding a local knowledge system. Last stage, 6) Introducing a multilanguage scientific-educational module to facilitate the cross-cultural accessibility and usability of the Indigenous Knowledge System (IKS) and ensure a cross-continental partnership.In networking engaged in the custom system and cooperation with the ministry of education or schools, it is pivotal to ensure that language must not hinder students to consume effective cross-cultural knowledge and skills.

The first and second steps designing the hybrid network of concept and developing a learning module based on the indigenous concept, practice, and product are in accordance with Sudarmin et al. (2018) and Suciyati &Adian (2018) on the development of an ethnoscience-based scientific learning module. Based on the research findings, developing a module in which indigenous knowledge of a community is integrated will improve students' understanding.

Meanwhile, Abonyi (1999) made an experiment of ethnoscience-based scientific learning in schools in Nigeria. The research involved two classes regarded as the experimental and control . Ethnoscience was integrated with the syntax of the learning model in the experimental group. In the group, after confronted with a phenomenon (the material used was thunderstorms), students were engaged in a discussion about the myth, folklore, rite, and practice relevant to the material learned. After the discussion, the teacher gave a Western scientific explanation regarding the phenomenon. Moreover, the control group was not given the myth, folklore, rite, and practice in regard to thunderstorms. Instead, the teacher gave a Western scientific explanation of thunderstorms. Here, ethnoscience-based learning is emphasized in the introduction, identification, and discussion about local knowledge relevant to learning materials. The dissimilarity between the two classes is local knowledge and Western scientific explanation.

Ethnoscience closely pertains to local knowledge. Local knowledge which has been converted into science can enrich learning materials (Kidman et al., 2013; Dwianto, et al., 2017). Therefore, designing ethnoscience-based learning materials should be accompanied by concerning the conversion of local knowledge into science. This will make students understand the scientific aspects of local or indigenous knowledge in their culture.

In some literature, we can find that indigenous knowledge is compared to western knowledge. It is believed that indigenous students understand nature using their cultural experiences (Lee, et al., 2012). To elevate indigenous students' interests and understanding of science, teachers should instruct them to analyze problems from the perspective of indigenous culture and find the method to combine local cultures and scientific western cultures (Aikenhead, 2001). This argument agrees with the previous one that converting local knowledge into science is needed.

Based on the study of some literature above, some principle aspects which need more attention in designing ethnoscience-based learning are ethnoscience constitutes knowledge owned by a community/people and relates to local perceptions, practices, ideas, beliefs, and technology derived from both past and present cultural practices and traditions.Often, local knowledge (indigenous knowledge) appears not scientific. Different from scientific knowledge, indigenous knowledge is holistic, functional, and adaptive to both social and natural environmental changes in nature. Furthermore, it has been inherited for thousands of generations.In education, ethnoscience functions as a bridge where students with different cultural backgrounds can access modern knowledge.Abonyi (1999) states four major steps to introduce innovations and technology used in an ethnoscience-based classroom (see the explanation in the previous session), two of which are designing a suitable concept network and developing a learning module following indigenous concepts, practices, and products.In an ethnoscience-based class, introducing ethnoscience (including myths, folklores, rites, and practices) should be subsequently followed with a scientific explanation. Some literature mentions the term western/western scientific and indigenous/non-western knowledge.The campus/school establishes relationships with local communities and indigenous institutions to ensure the flow of information, documentation of indigenous knowledge and encourage research on the hybridization of indigenous knowledge with advanced scientific knowledge.This is in line with the statement that schools or campuses can be the cause of the erosion of local wisdom because they provide new perspectives in seeing the world, but can also be a solution to preserving local culture if the curriculum and learning are structured by respecting local culture and its uniqueness (Reyes-García et al., 2010).

How to Design Ethnoscience-based Learning

The previous session of this research has discussed some literature regarding ethnoscience and ethnoscience-based learning. The discussion also covers how to arrange ethnoscience-based learning. Based on some important points highlighted from the discussion, can be listed the steps of designing ethnoscience-based learning as indicated in Table 2.

Table 2 presents the steps and several important points of the respective steps.The first step is making an inventory of indigenous knowledge. Two types of indigenous knowledge which should be identified are IK existing in students as innate knowledge and that existing in the community and strengthened by the information flow of the indigenous institution.As a part of ethnicity uniqueness, students have indigenous knowledge based on their life in ethnicity. Education aims to transfer knowledge and practical experiences through a scientific process and thereby allowing the learning process to also engage cultures.The integration of local wisdom in the teaching and learning process can facilitate the understanding of subjects that are developed on scientific knowledge, which is often distant from student's daily experiences, and thus can represent the first step to opening the gates on scientific literacy(Seraphin, 2014).

The second step is selecting learning materials. Because we cannot relate all learning materials to ethnoscience, we should select those compatible. The third step is designing a concept network and IK integration. Learning materials can relate to each other and one type of the IK. In this step, a between-concept relation/network is established, and compatible IK will be integrated with the concepts.The fourth step is IK or ethnoscience conversion into scientific knowledge. Often, students cannot understand ethnoscience. Hence, a scientific explanation is required to help students apprehend IK or ethnoscience being studied. The fifth step is developing learning materials, modules, or books in which ethnoscience is integrated. The materials, modules, or books greatly contribute to learning. They allow students to study effectively and understand both materials and ethnoscience elements in them.The sixth step is integrating ethnoscience in the syntax of the learning model. Before teaching, teachers should predetermine the model and syntax which will be used. Ethnoscience can be integrated into various learning models. Selected learning models should be compatible with learning objectives and contexts. To integrate ethnoscience, we should observe the syntax of a learning model. Integrating ethnoscience in the syntax of the learning model rests upon the learning objectives and materials as well as the type or form of ethnoscience materials which will be delivered or integrated. Ethnoscience can be integrated into the first, middle, or last part or throughout the parts.

Table 2
How to Design Ethnoscience-based Learning

Steps	Important Points
1. Making an inventory of Indigenous Knowledge (IK)	Schools/campuses should establish a relationship with the local community and indigenous institutions to ensure information flow and documentation of cross-cultural indigenous knowledge and encourage research on the hybridization of local knowledge with another advanced scientific knowledge (Abonyi, et al., 2014)
2. Selection learning materials which will be integrated with IK (Abonyi, et al., 2014)	We cannot integrate all learning materials with IK so we have to select the materials compatible with it.
3. Designing a concept network with suitable integration and relevance (Abonyi, et al., 2014)	We have to determine relevant concepts which can be integrated with IK.
4. Converting local knowledge/indigenous knowledge into science (Kidman et al., 2013; Dwianto et al., 2017; Abonyi, 1999)	Not all indigenous knowledge can be sought a scientific explanation, but as much as possible can be explained its relevance to science
5. Developing learning books or learning materials based on indigenous concepts, practices, and products (Abonyi, et al., 2014)	a. We should present and analyze problems from students' indigenous cultural perspectives and how local cultures and western scientific cultures can complementeachotherin students' daily experiences. b. We should be converted IK into a scientific explanation.
6. Integrating ethnoscience in learning models	At this stage, we determine which where the syntax of the learning model is used.

Integrating Ethnoscience in the Model of Problem-based Learning (PBL) in Biology Learning

Biology learning studies various phenomena as well as organisms and their environment, and the relationships between them.The scope of study in biology starts at the level of atoms, molecules, organelles, cells, tissues, organs and organ systems, organisms, populations, communities, ecosystems, and the biosphere (Molnar & Gair, 2013).One of the learning models that can be applied in biology learning is Problem-based Learning (PBL). Many people have been familiar with and used this model during a learning process, including biology learning. PBL is a pedagogical approach that allows students to learn while actively engaging with contextual and meaningful problems, and form self-directed learning habits (Yew & Goh, 2016; Gündüz et al., 2016).Problems presented in PBL must be authentic, quite complex but in accordance with students 'prior knowledge, and present students' real life, connecting learning activities and real word(Li & Chen, 2018; Simone, 2014).The learning process of PBL focuses on understanding the problem and providing alternative solutions to the problems that occur (Muhlisin et al., 2020).

The syntax of the PBL model (Kosasih, 2014; Hemker et al., 2017; Imandala et al., 2019) is: 1) Observing: orienting students to problems, 2) Inquiring: raising problems, 3) Reasoning: collecting data, 4) Associating: formulating answers, and 5) Communicating.At the observing stage, the teacher can direct students to observe a fact or phenomenon and the problems that occur. In the Inquiring stage, the teacher directs students to find and formulate problems. At the reasoning stage, students look for data. The search for this data can be through experimentation, observation, literature study, and other processes. In the associating stage, students make data analysis, make explanations and solutions. In the communicate stage, students present experimental results and solutions, and evaluate. At this stage, the teacher provides confirmation, discusses student work, and makes connections with other facts or theories.Referring to the syntax of PBL and the previous explanation of ethnoscience, we can design ethnoscience-based learning for biology learning as present in Table 3.

Table 3

Steps to Integrate Ethnoscience in Problem-based Learning

Steps	Explanation of steps
1	a. Determine the linkage of biological content to be studied with ethnoscience as the background of student life. b. Determine the ethnoscience identities.
2	Determine real problems that correspond to biological content and students' ethnoscience to be solved by students.
3	Determinine on what stage the ethnoscience will be included in the PBL syntax.
4	Arranging the conversion of ethnoscience into scientific science.
5	Determine the moral message or meaning in the ethnoscience studied.

Referring to the syntax and the previous explanation of ethnoscience, we can design ethnoscience-based learning for biology.The following is an example of the integration of ethnoscience in the syntax of PBL using the biology materials and ethnoscience identities in Table 4. The Tidung tribe is one of the original inhabitants of North Kalimantan (Suciyati et al., 2021). The tribe has folklore entitled *Legenda Batu Mambin* (the Legend of *Mambin* Rock) which tells the story of a grandmother and her grandson (Setyami et al, 2018). The moral of the story is that it is the prohibition of using animals as playing materials. This folklore fits perfectly with animal conservation material in biology learning. The real problem that occurs in the student environment in the region is the shrinking of endemic animal and plant biodiversity. Mangrove crabs, proboscis monkeys, mangroves, and other flora and fauna are decreasing in number. Folklore, real problems in the field, as well as biology learning materials regarding animal conservation can be integrated into a problem-based learning based on ethnoscience.

Table 4

Ethnoscience Identities According to Animal Conservation in North Kalimantan

Ethnoscience identities	Explanation of ethnoscience identities
Biology material	animal conservation in a mangrove forest
Location	North Kalimantan
Ethnicity	Tidung Tribe
Ethnoscience	folklore titled the Legend of *Mambin* Rock
Story plot	This story began when Yadu Usuk took care of her grandchildren when winnowing rice. Busy with her activity, Yadu Usuk was unaware of her grandchildren who were now playing with a mangrove crab he put on *tampah*. In the meantime, a gale and tidal waves attacked. Yadu Usuk took her grandchildren but could not run from tidal waves. After attacked by tidal waves, they turned into *mambin* rock or the rock which was cradling. We can see the *mambin* rock in Tanjung Batu Beach Tarakan North Kalimantan.

Considering the syntax, material, and form of ethnoscience above, it can be designed the ethnoscience integration as presented in Table 5. Table 5 shows that ethnoscience is integrated into the last step which is communicating. In this step, ethnoscience can be converted into a scientific explanation. The conversion of the *Mambin* Stone Legend into a scientific explanation is that we shouldn't make animals as toys. Using animals as toys can harm the animals and in the end there is a possibility of death. Consequently, they may extinct. From the conversion, students can also extract moral values or messages contained in the Legend of *Mambin* Rock.

Table 5

The Integration of Tidung Ethnoscience in the Syntax of Problem-based Learning (PBL)

No.	Syntax of PBL	Possible Ethnoscience Learning Activities
1	Observing: orienting students to problems	Observing an environmental problem in a polluted mangrove forest in which animals are rarely found
2	Inquiring: raising problems	Formulating problems
3	Reasoning: collecting data	Making an experiment, observation, or other processes
4	Associating: formulating answers	Concluding the data generated from an experiment/observation, seek explanations and solutions independently and in groups
5	Communicate	a. Communicate the result of experiment/observation b. Discussing the Legend of *Mambin* Rock c. Converting the legend of *Mambin*Rock to a scientific explanation d. Extracting the moral value or message from the Legend of *Mambin*Rock

CONCLUSION

There are three main findings from this study; 1) the new conceptual frame work wich is a synergy between ethnoscience and PBL to improve contextuality and meaning in biology learning, 2)steps in compiling ethnoscience-based learning, and 3)steps to integrate ethnoscience into PBL and how is it applied in biology learning. This research generates six procedures for designing ethnoscience-based learning which are: 1) Indigenous Knowledge (IK) inventory, 2) Learning material selection, 3) IK integration and conceptual network designing, 4) IK or ethnoscience conversion into scientific knowledge, 5) Learning book or learning materials development based on the concept, practice, and indigenous product, and 6) Ethnoscience integration into the learning model. To enhance the contextuality and the meaning of biology learning, integrating ethnoscience with the problem-based learning syntax can be conducted at any stage following the materials and the type of ethnoscience integrated.We can integrate ethnoscience in Problem-based Learning through 5 steps as follows: 1) Determine the relationship between biological content to be studied and ethnoscience that is the background of student life, and determine the ethnoscience identity to be integrated, 2) determine real problems that are in accordance with biological content or with student ethnoscience to be completed by students, 3) determining at what stage the ethnoscience will be included in the PBL syntax, 4) conversion of ethnoscience into scientific knowledge, and 5) determining the moral message or meaning in the ethnoscience studied.The real problems given at the PBL stage will provide contextuality and meaningfulness of biology learning. Meanwhile, ethnoscience-based learning, where local culture and indigenous knowledge are integrated here, will work together with PBL in enhancing the contextuality and meaning of biology learning. These findings provide a new conceptual framework derived from article review. The results of this study support the results of previous studies which state the increase in achievement in indigenous knowledge-based biology learning and learning with the PBL method. For teachers or researchers, this study recommends the use of procedures as a result of this study to design Ethnoscience-Based Learning and integrate Ethnoscience into PBL to improve contextuality and meaning of learning in the classroom. Another recommendation from this research is that it is necessary to carry out an ethnoscience inventory in each region/ethnicity in accordance with the content of biology learning. This ethnoscience inventory will make it easier to make connections between students' ethnoscience and the content of biology lessons tbeing studied.

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REFERENCES

Abonyi O.S., Njoku, & Adibe, M. I. (2014). Innovations in science and technology education: A case for ethnoscience based science classrooms. *International Journal of Scientific & Engineering Research*, *5*(1), 52–56. https://www.researchgate.net/publication/259657053_Innovations_in_Science_and_Technology_Education_A_Case_for_Ethnoscience_Based_Science_Classrooms

Abonyi, O.S. (1999). *Effects of an ethnoscience-based instructional package on student's conception of scientific phenomena and interest in science*. Publication of Doctoral Tesis. University of Nigeria.https://www.codesria.org/IMG/pdf/t_abonyi_okechukwu_sunday.pdf?6226/a05f035c759ca485c133853b73d49a0e98fcb1d1

Abonyi, O.S. (2003). Effects of an ethnoscience-based instructional package on students' conception of scientific phenomena. *Journal of the University of the Gambia* 1, 172 - 182.https://www.researchgate.net/publication/260674843

Aikenhead, G. S. (2001). Integrating western and aboriginal sciences: cross-cultural science teaching. *Research in Science Education*, *31*(3), 337–355. Retrieved from https://link.springer.com/article/10.1023/A:1013151709605

Ausubel , D.P,. (1963), *The Psychology of Meaningful Verbal Learning*. New York: Grune & Stratton Publishers

Carothers, C., Moritz, M. & Zarger, R. (2014) 'Introduction: Conceptual, methodological, practical, and ethical challenges in studying and applying indigenous knowledge'. *Ecology and Society*, *19*(4), 19–21. http://dx.doi.org/10.5751/ES-07212-190443

Cronin, P., Ryan, F., & Coughlan, M. (2008). Undertaking a literature review: a step-by-step approach. British Journal of Nursing, *17*(1), 38-43. https://doi.org/10.12968/bjon.2008.17.1.28059

Dewi, C. A., Khery, Y., & Erna, M. (2019). An ethnoscience study in chemistry learning to develop scientific literacy. Jurnal Pendidikan IPA Indonesia, 8(2), 279–287. https://doi.org/10.15294/jpii.v8i2.19261

Dwianto, A., Wilujeng, I., Prasetyo, Z.K. & Suryadarma, I.G.P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia, 6*(1) 23-31. doi: https://doi.org/10.15294/jpii.v6i1.7205

Fasasi, R. A. (2017a). Effects of ethnoscience instruction, school location, and parental educational status on learners' attitude towards science. *International Journal of Science Education*, *39*(5), 548–564. https://doi.org/10.1080/09500693.2017.1296599

Fasasi, R. A. (2017b). The Impact of Ethnoscience Instruction on Cognitive Achievement in Science. *International Journal of Education and Learning*, *6*(2), 33–42. https://doi.org/10.14257/ijel.2017.6.2.03

Gündüz, A. Y., Alemdağ, E., Yaşar, S., & Erdem, M. (2016). Design of a Problem-Based Online Learning Environment and Evaluation of its Effectiveness. *Turkish Online Journal of Educational Technology*, *15*(3), 49–57. http://search.ebscohost.com/login.aspx?direct=true&db=eue&AN=116811966&amp%5Cnlang=ko&site=ehost-live

Hariyadi, S., Tamalene, M. N., & Hariyono, A. (2019). Ethnopedagogy of the osing tribe folk song: exploration and formation of biology learning character. Biosfer: Jurnal Pendidikan Biologi, 12(2), 258-276. https://doi.org/10.21009/biosferjpb.v12n2.258-276.

Hemker, L., Prescher, C., & Narciss, S. (2017). Design and evaluation of a problem-based learning environment for teacher training. Interdisciplinary Journal of Problem-Based Learning, 11(2). https://doi.org/10.7771/1541-5015.1676

Ibe, E. & Nwosu, A. A. (2017). Effects of ethnoscience and traditional laboratory practical on science process skills acquisition of secondary school biology students in Nigeria. *British journal of Multidisciplinary and Advanced Studies1*(1) 35–46.

Imandala, I., Li, R., & Supriyadi, A. (2019). Analysis of Problem-Based Learning Models by Typology of Knowledge Pollock and Cruz (1999). *International Journal of Education and Learning*, *1*(1), 1–11.https://doi.org/10.31763/ijele.v1i1.12

Kidman, J., Yen, C. and Abrams, E. (2013). Indigenous students' experiences of the hidden curriculum in science education: A Cross-national study in New Zealand and Taiwan. *InternationalJournal of Science and Mathematics Education2013*(11): 43-64.http://dx.doi.org/10.1007/s10763-012-9365-9

Kosasih, E.(2014). *Strategi Belajar dan Pembelajaran Implementasi Kurikulum 2013*. Bandung: Yrama Widya.

Lee, H., Yen, C., & Aikenhead, G. (2012). Indigenous elementary students' science instruction in Taiwan: Indigenous knowledge and western science. *Research in Science Education*, *42*(6), 1183-1199. doi: https://doi.org/10.1007/s11165-011-9240-7

Li, H., & Chen, Y. (2018). Conceptions on PBL facilitator's role: A perspective of Chinese teacher. *International Journal of Learning, Teaching and Educational Research*, *17*(9), 18–33. https://doi.org/10.26803/ijlter.17.9.2

Marra, R. M., Jonassen, D. H., Palmer, B., & Luft, S. (2014). Why Problem-Based Learning Works: Theoretical Foundations. *Journal on Excellence in College Teaching*, *35*(3 & 4), 221–238. https://www.lhthompson.com/uploads/4/2/1/1/42117203/problem-based_learning.pdf

Muhlisin, A., Siswanto, S., Singgih, S., Dewantari, N., & Mohtar, L. E. (2020). Integration PBL with RMS: Improving problem solving skills on environmental education. *Biosfer*, *13*(2), 155–166. https://doi.org/10.21009/biosferjpb.v13n2.155-166

Molnar, C., & Gair, J. (2013). *Concepts of Biology (1st ed) Canadian edition*. Rice University.

Okwara, O. K., & Upu, F. T. (2017). Effects of ethnoscience instructional approach on students' achievement and interest in upper basic science and technology in Benue State, Nigeria.

International Journal of Scientific Research in Education, 10(1), 69-78.http://www.ijsre.com.

Pamungkas, A., Subali, B., & Linuwih, S. (2017). Implementasi model pembelajaran IPA berbasis kearifan lokal untuk meningkatkan kreativitas dan hasil belajar siswa. *Jurnal Inovasi Pendidikan IPA*, *3*(2), 118. https://doi.org/10.21831/jipi.v3i2.14562

Parmin, Sajidan, Ashadi, Sutikno, & Fibriana, F. (2017). Science integrated learning model to enhance the scientific work independence of student teacher in indigenous knowledge transformation. *Jurnal Pendidikan IPA Indonesia*, *6*(2), 365–372. https://doi.org/10.15294/jpii.v6i2.11276

Pierotti, R. (2016). Indigenous concepts of " living systems ": Aristotelian " Soul " meets constructal theory. *Ethnobiology Letters6*(1), 80–88. https://doi.org/10.14237/ebl.6.1.2015.420

Pilgrim, S., C. Samson and J. Pretty. (2009). Rebuilding lost connections: How revitalization projects contribute to cultural continuity and improve the environment. *Interdisciplinary Centre for Environment and Society Occasional Paper2009*(1). UK: University of Essex. https://www.semanticscholar.org/paper/Rebuilding-Lost-Connections%3A-How-Revitalisation-to-Pilgrim-Samson/ca453daabfd35fb4c86a27286a9aa24048ae2bdf.

Ramdhani, A., Ramdhani, M.A., Amin, A.S. (2014). Writing a Literature Review Research Paper: A step-by-step approach. *International Journal of Basic and Applied Science*, *3*(1), 47-56. https://www.researchgate.net/publication/311735510

Reyes-García, V., Kightley, E., Ruiz-Mallén, I., Fuentes-Peláez, N., Demps, K., Huanca, T., & Martínez-Rodríguez, M. R. (2010). Schooling and local environmental knowledge: Do they complement or substitute each other? International Journal of Educational Development, 30(3), 305–313. https://doi.org/10.1016/j.ijedudev.2009.11.007

Rist, S. and Dahdouh-Guebas, F. (2006). Ethnosciences - A step towards the integration of scientific and indigenous forms of knowledge in the management of natural resources for the future. *Environment, Development and Sustainability, 8*(4) 467–493. https://doi.org/10.1007/s10668-006-9050-7

Seraphin, K. D. (2014). Where are you from? Writing toward science literacy by connecting culture, person, and place. Journal of Geoscience Education, 62(1), 11–18. https://doi.org/10.5408/12-413.1

Simone, C. De. (2014). Problem-Based Learning in Teacher Education: Trajectories of Change. International Journal of Humanities and Social Science, 4(12), 17–29. www.ijhssnet.com/journals/Vol_4_No_12_October_2014/3.pdf

Setyami, I., Apriani, E., & Fathonah, S. (2018). Bunga Rampai Cerita Lisan Tidung Kalimantan Utara. Pustaka Abadi

Suciyati, A., & Adian, T. (2018). Developing the fun and educative module in plant morphology and anatomy learning for tenth graders. *Jurnal Pendidikan Biologi Indonesia*, *4*(1), 53. https://doi.org/10.22219/jpbi.v4i1.5334

Suciyati, A., Suryadarma, I. G. P., Paidi, & Abrori, F. M. (2021). Ethnobotanical study based on the five dimensions of basic life needs in tidung tribe of North Kalimantan, Indonesia. *Biodiversitas*, *22*(6), 3199–3208. https://doi.org/10.13057/biodiv/d220623

Sudarmin. (2015). Pendidikan Karakter, Etnosains dan Kearifan Lokal: Konsep dan Penerapannya Dalam Penelitian dan Pembelajaran Sains. FMIPA Universitas Negeri

Semarang. http://lib.unnes.ac.id/27040/

Sudarmin, S., Sumarni, W., Zahro, L., Diba, P. F., & Rosita, A. (2018). The Development of Learning Chemistry Module Integrated with Green Chemistry and Ethnoscience to Development of Students' Generic Science Skills and Soft Skills of Conservation in Central Java. Journal of Science and Mathematics Education in Southeast Asia, 41(5). https://eric.ed.gov/?id=EJ1247095

Suryadarma, I.G.P. (2017). Membangun karakter kemandirian satu pendekatan etnobiologi keunikan lokal dalam pespektif nasional dan refleksi global. Prosiding Seminar Nasional Biotik 2017, (pp 1-16). https://jurnal.ar-raniry.ac.id/index.php/PBiotik/article/view/2104

Thornton, T. F. and Scheer, A. M. (2012). Collaborative engagement of local and traditional knowledge and science in marine environments: A review. Ecology and Society, 17(3). https://doi.org/10.5751/ES-04714-170308

Ugwuanyi, E. C. (2015). Effects of an ethnoscience based instructional model on students' academic achievement and interest in the senior secondary school biology (unpublished master thesis). University of Nigeria Nsukka.

Usman, N., Rahmatan, H., & Haji, A. G. (2019). Ethno-Science Based Module Development on Material Substance and its Characteristics to Improve Learning Achievement of Junior High School Students. International Journal of Innovation in Science and Mathematics, 7(3), 148–157. https://www.ijism.org/administrator/components/com_jresearch/files/publications/IJISM_845_FINAL.pdf

Warrren, L. J. Silkeveer, and D.Brokensha (eds). (1995). *The Cultural Dimensions of Development: Indigenous Knowledge Systems*. Southampton: Intermediate Technology Publishers.

Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. Health Professions Education, 2(2), 75–79. https://doi.org/10.1016/j.hpe.2016.01.004