Student engagement in science learning through the integration of ethnopedagogy in wastewater treatment project

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Abstract. This paper describes a study to engage science students in learning about environmental pollution through the integration of ethnopedagogy in a wastewater treatment project. The study involved 40 year 7 junior high school students in Jakarta. In developing indigenous knowledge was explored, and cultural practices in dealing with environmental pollution in five region of Jakarta, Bandung, East Java, Central Java, and Banten, were integrated into the study. A qualitative research method used reflective journals, interviews, and a science concept test to gather data. The results show that ethnopedagogy integration in science learning engaged students in understanding their culture and learning identity, and developed their problem solving, critical and creative thinking skills. Conceptual understanding of the science was developed throughout the learning experiences. In addition, students have developed their skills in communication and collaboration through completing the project. Students faced the challenge of shifting their identity from passive to active learners using meaningful and enjoyable learning experiences.

1. Introduction
The richness of the traditional culture of Indonesia should be prized as part of the national identity. Cultural identity awareness must be embedded in the life of young Indonesians. Multicultural education is a basic element of modern education, influencing young people’s interactions in their own ethnic culture [1]. The application of education with a multicultural background is impossible without a system aimed at establishing ideas about cross-cultural diversity in behavior and thinking [2]. Ethnopedagogy is an effective tool for connecting culture and science. Ethnopedagogy can develop the right attitude towards national cultural values [3]. In this study, students were challenged to rethink the importance of their people’s traditional values in their own lives [4]. The purpose of ethnopedagogy is the attainment of syncretism or the reconciliation of two or more cultural elements or systems with the modification of both [5].

Student engagement has historically and primarily focused on increasing positive behaviours, achievement, and students’ sense of belonging so that they might remain engaged in school and class activities [6]. “Relevancy” is a common element for engaging students where students who work with community issues or problems develop a sense of purpose and engagement in the experience of learning [7].
Science learning is closely related to how students construct their knowledge. This is important for students learning about environmental education. The purpose of environmental education is to establish a world population that is concerned about environmental problems and have the attitudes, knowledge, motivations, skills, and commitment to work collectively and individually toward solutions to current problems [8]. The cultural background of students strongly influences the way they learn. The cultural background brought by teachers and students into the classroom greatly determines the conditions and atmosphere of meaningful learning [9]. Ethno-pedagogy is connected to the background of certain ethnic groups [10]. In this study, students’ learned about environmental pollution, especially how to overcome water pollution, using traditions and cultures from 5 regions in Indonesia through a wastewater treatment project based on the traditions and cultures, they have learned. The study observed students’ engagement in science through learning activities.

2. Method
This paper portrays the influence of ethnopedagogy in a wastewater treatment project to engage science students in learning about environmental pollution. The study used qualitative research methodology with multiple data collection methods consisting of reflective journals, interviews, and a science concept test. The stages of ethnopedagogy learning, integrated into project-based learning model, consisted of five learning steps as shown in the figure 1.

3. Results and discussion
The results show that the ethnopedagogy integration in science learning engaged students in understanding their culture and learning identity, in developing their problem solving, critical and creative thinking skills, and developed their skills in communication and collaboration whilst completing the wastewater treatment project.

3.1. Science conceptual understanding
Science conceptual understandings were developed throughout the learning process, as can be seen in the following statement.

“Environmental damage occurs because of the presence of contaminants called pollutants. Dirty river water is a sign that water has been polluted by pollutants. The characteristics of non-polluted water are clear water that does not cause odour. The way to prevent it is to clean each other's environment.” (Student’s worksheet, 14 March 2019)
Students learned about environmental education. They used the process of clarifying concepts and recognizing values to develop the attitudes and skills necessary to understand the environmental problems, and the interrelatedness among people, their culture, and their biophysical surroundings to solve the problems [11]. Science conceptual understanding of environmental education helped establish students’ values and awareness in order to improve the quality of the environment and people’s lives in different culture.

3.2. Cultural and learning identity
Understanding cultures and self-identification is the first step students take in the learning process. Students discussed with their group members ways of preventing water pollution in 5 different regions in Indonesia. Group were made up of a mix of students from different cultures. In the workplace, team members must deal with cultural differences actively in order to correlate cultural borderlines [12].

Based on the interview transcript below, students increased their understanding of their cultural identity during the project process. They realized that they have the responsibility to preserve their own culture. While it is important that cultural experiences and identity alter how students view their world [13], it also encourage students’ motivation to learn about and take on the challenges and problems in their lives.

(Student interview, 12 March 2019)

3.3. Problem solving skills
Students want to experience work that is meaningful [15]. They want to solve real problems, work with ideas that matter, get knowledge from each other, learn from people in their communities, as well as from experts in science who is most often their teacher, engage in discussion in their classes, and understand that their learning can contribute to make a difference in the world. These conditions motivated students to put in extra effort when they were learning about water pollution in class.

During the project, the students were challenged to shift their identity from passive to active learners, and in doing so they developed their learning identity. This learning process provided students with the means, spaces and educational support to help them understand how they can become individual learners when conditions change in different situations and why they do so [14].


Student: Ciliwung.
Teacher: What do you know about Ciliwung?
Student: It is dirty and muddy.
Teacher: How can we purify the river?
Student: We can use a tradition from Bandung that is Nuras Cai. We can work together to purify the water in Ciliwung river, and we also can use Tempayan that is a culture from Jakarta. We can put the water from Ciliwung river into tempayan, the water can be cleared with Tempayan (crock or container), traditions from Jakarta. Water is deposited in two tempayans containing gravel and sand that have the function as a water filter and we need pieces of charcoal for changing colors and odors of the water of Ciliwung river. (Student’s interview, 12 March 2019)

Students today are intensely social and interactive learners [16]. Teachers have to facilitate collaborative activities. The wastewater treatment project was undertaken using purified materials that were almost the same as the Tempayan tradition with a container of reused bottles as seen in the figure 2. Through interviews, the study found that students who participated in the problem-based learning activities successfully improved their ability to recall and retain information about environmental pollution and the cultures from different regions.

![Figure 2. The wastewater treatment project.](image)

3.4. Collaboration and communication skills
Based on the samples from a student’s reflective journal below, students from different cultures successfully completed their projects by collaborating in class. Collaborative activities helped to increase the students’ problem-solving skills by allowing them to work on problems together that were difficult to solve individually. Grouping students based on the differences in ethnic groups, achievement levels, and gender could help students develop empathy towards others. Listening and respecting others’ opinions is a characteristic of empathy in accepting another person’s perspective [17].

“I successfully make the wastewater treatment because I did collaboration with my team members. It was easier because we did it together.” (Student’s reflective Journal, 14 March 2019)

Teacher: Please present your wastewater treatment project!
Student: Our wastewater treatment project is failed. When we pour the dirty water to the bottle that has some purify materials, the water is still dirty. We do it repeatedly but the results remain the same.
Teacher: What did you learn from your failed project?
Student: It happened because we did not put purify materials into the bottle carefully so it did not form a perfect layer of purifying materials. For the next project, we would like to do it according to the instruction given and do it carefully. (Students’ group presentation, 13 March 2019)
Based on student interview statements, and reflective journal as above, this project developed students’ ability to engage with one another, to evaluate their ideas, monitor their work together and handle failure while they solved a problem. Students realized that they could finish the project by collaborating and communicating effectively. Respectful relationships and interaction – both virtual and personal – are shown to improve student engagement. Students want to interact with other people both beyond and within the school environment [6]. They want to communicate and connect constantly and need an environment to promote these connections.

3.5. Critical and creative thinking skill
Students developed their critical and creative thinking skills through this learning process, as can be in the interview transcript below. Some students tried different kinds of solutions with water that they bought into the classroom to experiment whether the system of this water treatment project could filter various types of dirty water. Students solved various unfamiliar problems in creative ways.

**Teacher**: How is the result of your wastewater treatment project?
**Student**: We successfully made it. After I put a glass of dirty water from the teacher and the water successfully became clearer, I went to the canteen for buying a glass of iced tea and then I tried to pour it down to the bottle that has purify materials. My wastewater treatment can make the glass of a tea become colourless water.

**Teacher**: Who has the idea and why did you do it?
**Student**: This is my idea. I want to make sure is it possible that a glass of tea becomes colourless. I also want to know how it works. *(Student’s interview, 13 March 2019)*

Students developed their capability in creative and critical thinking as they learned to evaluate and generate water pollution knowledge, clarify ideas and concepts, look for responsibilities, solve problems and consider alternatives. Critical thinking not only shows the ability to think in harmony with the rules of probability and logic but also the capability to adjust these skills to real-life problems. Creative and critical thinking encourage an individual to be sensitive to problems [18]. Creative and critical thinking can prepare students to have more insightful understanding of themselves. It provides students an opportunity to be less emotional, and objective, and more open-minded to appreciate others’ opinions and views [19].

4. Conclusion
The Integration of ethnopedagogy in a wastewater treatment project can develop students’ engagement in learning science. The study found that the project developed science conceptual understanding, awareness of cultural and learning identity, problem-solving, collaboration and communication skills, and critical and creative thinking. Students learned how to preserve the environment and they showed an attitude of caring for environmental pollution and how to prevent it with projects related to their cultures. The challenge of this study was encouraging students to express what they felt about the learning process.

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