A Multicultural Teaching Framework for Physics

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ABSTRACT

This paper presents a framework for integrating varying cultural elements in the teaching of physics concepts. The framework is based on a study on the effects of a multicultural physics teaching approach on student concept understanding and attitude towards physics.

INTRODUCTION

The UNESCO has identified that one of the pillars of learning for the 21st century is an education system that develops one's understanding of other people and their culture (Science Education of Asian Countries, 1999). In the 1999 conference on Science Education of Asian Countries, it was cited that cultural diversity must be one of the considerations during the process of science curriculum development. Some science education experts also support that scientific literacy for all students can be achieved if the science curriculum reflects the diversity of the society (Madrazo & Rhoton, 2001).

However, there are science educators who have contrary views and consider multicultural education irrelevant to science and mathematics but more appropriate for social studies, language, music, and arts (Boutte, 1999). Similarly, Rosenthal reported that there are scientists and educators who believe that there is no need for multicultural education in science because science is culturally neutral, inherently universal, and global in perspective (Morey & Kitano, 1997).

In 1998, Samuels developed and evaluated a collection of multicultural materials for teaching mathematics in middle schools in Bermuda. The study revealed that the materials were favorably evaluated and found to be interesting, motivational, and appropriate for the Bermudian context. Samuels' study also established that it was possible to develop materials that satisfy both multicultural education and mathematics teaching (Samuels, 1999).

In the Philippines, Reyes-Matipo (1997) conducted a study on ethnic diversity and physics education. The study revealed that there were significant differences in the attitude and achievement in physics among four different ethnic groups. Based on the findings of the study, it was recommended that physics instruction should be infused with customs and traditions of the groups to attain optimal science learning (Reyes-Matipo, 1997).

In 2002, the Department of Education (DepEd) in cooperation with the College of Education of the University of the Philippines created the Culture-Responsive Curriculum for Indigenous Peoples (CCIP) to show its commitment in providing a curriculum that is relevant and suitable to the way of life and needs of indigenous peoples. The CCIP proposed a restatement of the goal of science and health in the revised basic education curriculum; that is, "demonstrate understanding of how science, technology, and health relate to the comprehension of the local environment and culture, and application of skills, attitudes, and

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values in dealing with varied life situations (DepEd, 2002)."

Consolidating the aforementioned global and national perspectives and studies on multicultural education in science has led to the conceptualization of a study on a multicultural teaching approach in physics. This paper presents the method and results of a study on the effects of a multicultural physics teaching approach on student concept understanding and attitude towards physics. It culminates in a multicultural teaching framework that can be used by other physics educators in their own attempts to explore multicultural education in physics.

EFFECTS OF A MULTICULTURAL PHYSICS TEACHING APPROACH ON STUDENT CONCEPT UNDERSTANDING AND ATTITUDE TOWARDS PHYSICS (Carreon, 2004)

In 2003, the researcher conducted a study on the effects of a multicultural physics teaching approach on student concept understanding and attitude towards physics. Varying cultural elements of the five dominant ethnic groups in Isabela were integrated in the teaching of physics concepts, principles, and laws.

Subjects

The study involved sixty-one 15-year-old students who were incoming seniors in a private high school in Santiago City, Isabela. Thirty students were exposed to the Multicultural Physics Teaching Approach (MPTA) and 31 students were exposed to the Nonmulticultural Teaching Approach (NMTA).

Procedure

Prior to the instructional phase, the students answered a physics concept understanding test and an attitude scale towards physics which were both developed by the researcher. The concept understanding and attitude towards physics of the students from the two classes were found to be comparable prior to the treatment.

Cultural elements coming from the five dominant ethnic groups of the locality (Ilocano, Ibanag, Gaddang, Yogad, and Tagalog) were used to teach physics concepts. The cultural elements were composed of ethnic games, myths and legends, important places, and musical instruments derived from books and interaction with the cultural coordinator of the locality. The cultural elements were integrated using the inclusion strategy and artifacts strategy. The MPTA class was exposed to teaching/learning activities such as games, inquiry, role play, reading activity, challenge activities, POE (Predict, Observe, Explain), lecture-discussion, demonstration, exploration activity, musical presentation, creative problem solving, puzzle, illustrating scenes, quizzes, and creating toys. The researcher taught both classes and requested a science teacher from the host school to observe regularly. The other class, the NMTA class, was only handled differently from the MPTA class in terms of cultural integration. The learning activities for the NMTA class were almost parallel to those of the MPTA class.

The physics concept understanding test and attitude scale towards physics were administered again after the instructional phase.

Results

Using the one-tailed *t*-test for independent samples, the mean post-test scores in the physics concept understanding test of the MPTA and NMTA classes were compared and found to have no significant difference at $a = 0.05$.

The same statistical test was used to analyze the mean post-test attitude rating in the attitude scale towards physics of the two classes. The analysis revealed that the mean post-test attitude rating of the two classes did not differ significantly at $a = 0.05$.

Table 1 shows the summary of the tests of the difference between the mean post-test scores of the two classes in the physics concept understanding test and the mean post-test attitude ratings in the attitude scale towards physics.

Further analysis of the concept understanding score of the two classes in each item showed that the MPTA and NMTA classes significantly differed in seven items. The MPTA group had a higher mean score in five out

Table 1. Tests of difference between the mean post-test scores and mean post-test attitude ratings of the MPTA and NMTA classes.

Instruments	Class	Mean Score/ Rating	SD	Significance level (one-tailed)
Physics Concept Understanding Test	MPTA	15.97	5.007	0.341
	NMTA	15.45	4.760	
Attitude scale towards Physics	MPTA	77.83	10.164	0.334
	NMTA	78.87	8.523	

*Perfect score in the Concept Understanding Test = 40.
**Perfect Attitude rating = 100.

of seven items in which the two groups differed significantly. The concepts that were tested in the five test items were the final velocity of an object (thrown upward) at maximum height, acceleration of an object (thrown upward) at maximum height, total energy of a system after energy transformation without heat loss, change in speed of a fluid as it flows into a smaller pipe, and relation of loudness of sound to amplitude and pitch to frequency.

The attitude rating of the two classes in each item of the attitude scale was analyzed and found to significantly differ in only one item. The item was "Physics is not needed in our society." Since the item was negatively stated, the scoring was reversed. The MPTA class had a mean rating of 4.63 in that item, while the NMTA class had 4.32. The highest possible rating per item was 5.

Discussion

The Multicultural Physics Teaching Approach had no general effect on student concept understanding and attitude towards physics. However, it could improve student understanding of certain physics concepts. It could also help students recognize that physics is needed in the society.

The researcher noted two factors that might have affected the results of the study: the cultural awareness of the MPTA students and the time the study was conducted.

The cultural elements that were used in the study were researched from books, based on the interaction with the cultural coordinator of the locality, and drawn from the cultural experiences of the researcher who grew up in the locality. Although the students could identify to which ethnic group they belong to, they did not recognize the cultural elements of the dominant ethnic groups. They appreciated the elements when they were told that the inputs were part of their culture.

The other factor that could have affected the results of the study was the time it was conducted. The study was conducted during summer break. One of the recommendations was to duplicate the study during a regular school year.

MULTICULTURAL TEACHING FRAMEWORK FOR PHYSICS

From the experience and results of implementing a multicultural physics teaching approach, the researcher proposes a multicultural teaching framework that can be used by other educators who may wish to explore the integration of cultural elements of other ethnic groups that are not cited in this study. Figure 1 shows the multicultural teaching framework for physics.

Preparation

The first step in the preparation for multicultural teaching begins with identifying the dominant ethnic groups represented in the class. This can be done by fielding a questionnaire that can probe on the students' parentage, identification with an ethnic group, length of stay in the locality, and spoken dialect.

Second, search for the cultural elements of the dominant ethnic groups that are represented in the class. Local plants and animals, important places, natural resources, beauty spots, local literature, local materials, local costume, local music, beliefs and practices, indigenous knowledge, local food, local history, ethnic games, and local musical instruments can be considered as cultural elements (DepEd, 2002). Search for supporting literature and consult with the cultural authorities of the locality to validate the identified cultural elements.

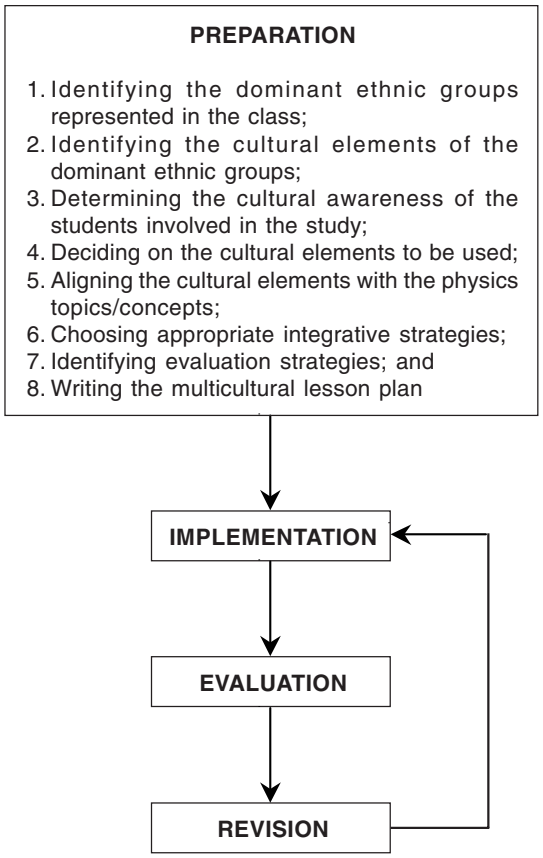

Fig. 1. Multicultural teaching framework for Physics.

Third, determine the cultural awareness of the students involved in the study. Provide a list of the cultural elements of the dominant ethnic groups and ask the students to identify the elements that they practice or are quite familiar with.

Fourth, based on the cultural elements that are familiar to the students, prepare the list of the classified elements that will be used in the study.

Fifth, align the identified cultural elements with the physics topics/concepts. The cultural elements should naturally blend in the content. They should not divert the class from the track of the lesson, rather, they should serve as the catalyst to the development of the lesson or they should further enrich the lesson.

Sixth, select appropriate integrative strategies. The CCIP has identified the following integrative strategies: inclusion strategy and artifacts strategy. The inclusion strategy uses indigenous knowledge and cultural elements as examples to demonstrate concepts and make students realize the connection between their culture and science learning (DepEd, 2002). Ethnic games, myths and legends, and local beliefs and practices are some of the cultural elements that can be considered for the inclusion strategy. The artifacts strategy relies on the use of actual objects that are indigenous to the place or are created by the local people (DepEd, 2002). Local musical instruments, plants, products, materials, and ethnic costumes can be used for this strategy.

Seventh, identify the evaluation strategies. Use strategies that are suitable, learner-centered, and that enhance active learning, critical and creative thinking, problem solving, and cooperative learning.

Eight, organize the cultural elements, physics topic, integrative strategy, and evaluation strategy in a cohesive lesson plan.

Implementation

The implementation of the multicultural lesson plan should be done objectively. Present both the similarities and differences of the cultural elements of different ethnic groups. Emphasize that there should be no issue regarding superiority or inferiority of the cultural elements. Also, look into the inconsistency of certain cultural elements with physics concepts, principles, and laws. Objective learning should prevail over appreciation of cultural heritage.

Evaluation

Evaluate the different aspects of implementation of the multicultural lesson plan such as students' reaction to the integration, facilitation of the lesson plan, and students' scores and outputs in the evaluation activities.

Revision

Revise the multicultural lesson based on the results of the evaluation. Strive to implement the revised multicultural lesson plan.

IMPLICATIONS TO PHYSICS EDUCATION

Multicultural physics teaching may not have a general effect on student concept understanding and attitude towards physics, but it can improve the understanding of certain concepts and can also help students realize that physics is needed in our society. In this essence, multicultural physics teaching has considerable impact in making science more relevant and meaningful to the students, which is one of the primary objectives of education today.

The framework presented in this paper describes how physics educators can further study the integration of varying cultural elements in teaching physics concepts, principles, and laws. Only five ethnic groups from the northern region of the country were explored in the study. As there are 77 major ethnic groups in the Philippines, the study is an initial step towards exploring the potential of multicultural physics teaching in our country. Its effects on other aspects of the physics learning process are also possible areas of study for other researchers.

Although this framework is drawn from a multicultural teaching experience in physics, the steps of the multicultural teaching framework can also be adapted by other disciplines.

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