

Effects of Instructional Design Integrated With Ethnomathematics: Attitudes And Achievement

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Abstract: Development of an instruction integrated with ethnomathematics and its effects on 7th grade students' attitudes towards mathematics & achievement levels are the main concerns of this paper. Participants were selected from the 7th grade students. Six hours of instruction consisting of transformational, reflectional and rotational symmetry, patterns and ornaments based on the mathematics used in Topkapı Palace were presented to treatment group. An attitude scale, two achievement tests were administered as pre and post tests. Repeated measures two way ANOVA was used in order to test the hypothesis.

Introduction

Schools tend to ignore the ethnomathematical knowledge that the children themselves can bring into the classroom from their homes and communities although math is not a culture-free discipline (Zaslavsky, 1998), therefore mathematical concepts and ethnomathematical perspectives should be synthesized in the curriculum in a way which is sensitive to all cultures. Development of an instruction integrated with ethnomathematics for 7th grade math lessons and its effects on students' attitudes towards mathematics and achievement levels are the main concerns of this paper. Practical mathematics and scholarly mathematics are tried to be narrowed with the instruction developed in the study.

D'Ambrosio (2001) states that ethnomathematics encourages us to witness and struggle to understand how mathematics continues to be culturally adapted and used by people around the planet and throughout time. In traditional math classes there exists no connection between culture and mathematic. As a result of this practice students believe that there is no connection between them and math is "acultural" which means that a discipline without cultural significance. Researches show that achievement level in math is highly correlated with students' attitude towards math. Butty (2001) noted that students with better attitudes towards math had a significantly higher achievement scores than those with poorer attitudes toward mathematics. Schultes and Shannon (1997) found that many students gained greater appreciation for math after learning the subject matter from a cultural perspective since it made students more comfortable and confident about discussing mathematical concepts such as infinity with their peers. (Cited in Arishmendi-Pardi, 2001).

Literature Review

All of the definitions of ethnomathematics consider the points such as the culture in which mathematics arise, mathematics that is implicit in cultural in cultural practices, the use of anthropological principals to investigate mathematical practices, relation and implications for mathematics education. The definition of D'Ambrosio, which is the mathematics practiced among identifiable cultural groups, such as national-tribal societies, labor groups, children of a certain age bracket, professional classes (D'Ambrosio, 1985; cited in 1997, p. 16) is used as the main focus of the instruction integrated with ethnomathematics. Besides Zaslavsky (1998) stated that ethnomathematics includes mathematics of people's ethnic and racial group's, various classes in the society and practices of students' own communities.

The researches on ethnomathematics attempts to supplement the existing curriculum through the cultural practices and or/and examine the outcomes of integrating ethnomathematics into classroom instruction. There are many studies that seek to supplement the curriculum and their focus is usually on indigenous cultures (e.g. Barta, Abeyta, Gould, Galindo, Matt, and Seaman, 2001; Gerdes 1988; Lipka, Hogan, Webster, Yanez, Adams, Clark, and Lacy, 2005; Morales 1993). Studies that focused on outcomes did this through an examination of cultural practices and or artifacts, students' home/everyday experience or students' cultural practices. In general related research studies reach to similar conclusions that integrating ethnomathematics into mathematics instruction has positive effect on students performances (Arishmendi Pardi, 2001; Lipka et. al, 2005; Brenner, 1998).

The literature review showed that people use the mathematical activities in their real life with cultural practices, artifacts (Morales, 1993). In everyday activities, people involve a substantial amount of mathematical applications, which are universal behaviors such as counting, measuring, designing, clothing, explaining, playing and for example, when designing tools, patterns are used especially for clothing, weapons (Bishop, 1991 as cited in Barta et. al, 2001). Moreover Moses (2005) noted that students' achievement levels in mathematics increased as they learn about African culture. The grades of algebra course of students taught

ethnomathematical pedagogy were higher than the students' who took without the ethnomathematical pedagogy (Arishmendi-Pardi, 2001). The connection between mathematical ideas and lived experience of individual students, were emphasized in the study of Presmeg (1998) which argues that the ethnicity of students is a resource for mathematics. Powell and Temple (2001) say that Oware which is a board game played in Africa can help children understand that humans encode their mathematical ideas in diverse cultural products, including architecture, art games, music and written texts. Gerdes (1998) argued to develop an awareness of the social and cultural bases of mathematics, which contributes both to enhance self-confidence, capacity, readiness and openness to work in a multicultural environment among future math teachers. Teachers can make students see that in their activities, there are mathematics engaged in and they know math (Gerdes 1998). Barkley and Cruz (2001) noted that Native American beadwork incorporated in daily lives shows a high degree of sophistication in terms of specific symmetrical patterns which are used to symbolize the balance and communicate people's feeling of harmony with the natural world in which they lived. Gerdes (2001) suggested that teachers may look for suitable activities from diverse cultural contexts and analyze how these activities may be integrated into their teaching to create a truly simulating and enriching environment to help all students fully develop their potentials. Lipka and his colleagues (2005) found that the results of students' mathematics performance were in favor of the instruction which is math in a cultural context and based on two case studies of a successful culturally based math project.

In the light of the studies conducted on ethnomathematics, the purpose of this study is to investigate the effects of math instruction integrated with ethnomathematics. Specifically to find out if there will be any statistically significant difference between the level of attitude towards mathematics and mathematics achievement levels of seventh grade students who receive instruction integrated with ethnomathematics and regular instruction.

Methodology

All of the definitions of ethnomathematics consider the points such as the culture in which mathematics arise, mathematics. In this section, the experiment set-ups and procedures will be described. These include the participants, the instruments, the data collection process, and the analytical procedure.

Participants

Fifty students in seventh grade participated in this study. Due to practical reasons, convenient nonrandom sampling technique was used. The school is a state supported school, which has two seventh grade classes. One of the classes was control group (n=30) treated with the regular instruction and the other one was treatment group (n=20), treated with the instruction integrated with ethnomathematics.

Design

In this quasi experimental study, since the participants were selected non-randomly except the random assignment of intact groups to treatments the design may be called as non-equivalent control group design (Gay, 2003). Before the treatment, Mathematics Achievement Scale1 (MAS1) and Mathematics Attitude Scale (MATT) were administered as pretest to all control and treatment groups. After the treatment, in order to find out achievement and attitude differences MATT scale and Mathematics Achievement Scale2 (MAS2) were administered as post tests.

Instruments

In order to determine students' attitude towards mathematics at the beginning and at the end of the study, students were given mathematics attitude scale (MATT) which was developed by Nazlıcıçek and Erkin (2002). The reliability of MATT was calculated with the Cronbach Alpha Coefficient which is .81 for the sample 234 students from 6th, 7th and 8th grades. For the content validity of the test, factorial analysis of variances was conducted and in three subscales -which are mathematics achievement level perceived by the students, the benefits of mathematics perceived by the students and interest toward math lessons- 52 percent of the variance explained. For construct validity of the scale, the correlation coefficient between students' attitudes towards mathematics and their math achievement is found as .36 which is statistically meaningful for .01 significance level. According to Nazlıcıçek and Erkin (2002) this value was consistent with the previous studies Minato and Yanese, (1984); Ethington and Wolfle, (1986); Cheung (1988); Erkin, (1993).

In order to measure students' knowledge on the prerequisite topics for the symmetry and patterns (angle, line and plane using protractor to measure angles, basic characteristics of polygons), Math Achievement Scale 1(MAS1) was developed and used as a pre-test. Mathematics Achievement Scale 2 (MAS2) was developed for the line symmetry, rotational symmetry and patterns topics and used as a posttest. Both of instruments were developed by the researchers. The questions were adapted or directly taken from nationwide Teacher Guide Book of 7th Grade (Aygün, S.Ç., Aynur, N., Çuha, S.S., Karaman, U., Özçelik, U., Ulubay, M., Ünsal, N., 2007). For content validity of the instruments two mathematics teacher with master degree judged

whether they evaluate students' knowledge on the prerequisites of symmetry and patterns topics for MAS1 and all subtopics of the symmetry and patterns topics for MAS2.

Procedure

This section includes the description of the treatments, which are instruction integrated with ethnomathematics and regular instruction in "Mathematics in Our Daily Life" chapter. Both experimental and control treatments lasted in six-lesson hours. All of the instructions were implemented by the same mathematics teacher who is one of the researchers.

Instructions were prepared for the symmetry and patterns topics of the 7th grade math lessons. Both of them are developed according to the objectives of 7th grade mathematics curriculum of National Education of Turkey, as stated in Teacher Guide Book of 7th Grade (Aygün, et al., 2007).

The regular instruction was based on the activities stated in the text-book. The instruction integrated with ethnomathematics for the 7th grade symmetry and patterns topics aimed to enrich the existing curriculum with the cultural artifacts and ornaments. This type of instruction was based on the second strand of ethnomathematics defined as the analysis of the mathematics of the traditional cultures and of indigenous people and the fourth strand which focuses the relationship of ethnomathematics with the formal education system (Vithal and Skovsmose, 1997). It was designed according to mathematics of the tiling and patterns of the rooms called as Murat III Private Room, Mother of Sultan Flat in Topkapı Palace, practiced by the carpenters and tiling experts and the reasons behind the usage of the mathematics in those rooms by integrating to the instruction stated Teacher Guide Book of 7th Grade Chapter 5, prepared according to mathematics curriculum of National Education of Turkey. Students discovered the use of symmetry and patterns Turkish ornaments and Topkapı Palace which has an important role in Turkish History and full of symmetric ornaments. After a PowerPoint and a video show with photographs was shown, the selected rooms in the Harem section of Topkapı Palace, were examined with a simulation named as "360 degree" which makes use to see all the room within different perspectives. The motifs and ornaments are examined one by one with their photographs in the presentation and in the worksheets. Students made activities to define pattern types in the ornaments of to answer the questions: *Does the shape have rotational symmetry? If yes, what is the minimum angle that we should rotate to have the shape in the same position? Does the shape have reflectional symmetry? Does the shape have reflectional symmetry more than one axis? Is there any translation of the main motif?* Then social and architectural properties of Harem Section was explained to students. Some of the properties are as follows:

This is the house of the Ottoman emperor where his family lives so reflects the family life of the emperor. It was forbidden to enter the foreigners to enter Harem Section. Harem section was dark and cold since there were very few windows because of its secrecy. There was a hierarchical placement in the rooms and the most important people rooms' ornaments had higher complexity than the less important ones. The ornaments do not include animated figures because of religious reasons. Geometrical figures and flowers are used in tiling, cushions and carpets. The pools and taps were to cool off in the summer, and also for hygienic reasons. Another usage was not to make others listen outside of the room. When somebody is talking, another person outside of the room cannot hear anything if the tap was opened. The basic living problems were secrecy, light and heating. To make the rooms hotter there were fireplaces. The walls were full of tiling with symmetrical figures to reflect the heat and to foreclose humidity. There were candle places in the walls and they were also full of those figures. The carpets on the ground and hang in front of doors and windows were also to avoid cold weather. In the rooms, there were three types of ornaments which are calligraphy, flower designs and patterns with repeated polygons-tessellations. The third type was related with the instruction integrated with ethnomathematics. Their basic characteristics is having infinitely continued, symmetrical and n-sided.

The main difference between the instruction integrated with ethnomathematics and the regular instruction is the shapes used in the activities. The regular instruction activities, as stated below consist of the shapes and examples in the geometry. On the other hand in the activities of the instruction integrated with ethnomathematics, the shapes are chosen from The Flat of Valide Sultan and Room of Murat III. The other difference is that students in the experimental treatment also learn about Turkish history and lifestyles of the people who were living in the palace in the past centuries. The worksheets which were implemented as class exercises during experimental treatment are parallel to the students' practice and activity parts stated in the Teacher Guide Book of 7th Grade Chapter 5. However the shapes were selected from the patterns and ornaments of Room of Murat III and The Flat of Valide Sultan. In addition, they were prepared in the ethnomathematical perspective.

Both of the instructions include the use of the symmetry and patterns in daily life. In regular instruction it is presented with only examples, without any explanation or reason about the usage of them. The instruction integrated with ethnomathematics on the other hand includes the use of symmetry and patterns with reasons in a cultural context.

Data Analysis and Results

Firstly, the distribution of the a) MATT as a pretest and b) MATT as a posttest c) MAS1 and d) MAS2 scores of the students in the treatment and control group were determined. Normality tests of Kolmogorov-Smirnov and Shapiro-Wilk showed that these scores are not significantly different than the scores which have normal distributions.

Since two dependent variables are measured repeatedly on independent groups where each group is exposed to a different condition Repeated Measures Analysis of Variance (ANOVA) was conducted for control and treatment groups. In order to determine whether control and treatment groups are significantly different or not in terms of their attitudes towards mathematics (MATT test scores) and mathematics achievement levels (MAS1 scores and MAS2 scores) at the end of the treatments, Repeated Measures Two Way ANOVA were carried on the pretest and posttest scores of two groups for both of the variable. Descriptive statistics are presented in Table 1.

Table 1: Descriptive Statistics for Attitude towards Mathematics and Mathematics Achievement.

	Control Group		Treatment Group		TOTAL	
	Mean	SD	Mean	SD	Mean	SD
N	30		20		50	
Pretest						
MATT	41,97	12,694	55,50	20,433	47,38	17,382
MAS1	66,83	14,130	66,00	16,746	66,50	15,069
Posttest						
MATT	33,32	10,346	58,42	15,812	43,36	17,739
MAS2	64,43	13,756	67,05	13,193	65,48	13,459

First hypothesis of the study was; *there will be statistically significant difference between the mathematics achievement levels of seventh grade students who receive instruction integrated with ethnomathematics and regular instruction* was not supported. Repeated Measures Two way ANOVA for control and treatment groups' scores on MAS scores revealed that ($F=1.812$, $p=.185$) the difference between the groups in terms of mathematics achievement was not statistically significant.

Second hypothesis of the study; *There will be statistically significant difference between the attitude levels of seventh grade students who receive instruction integrated with ethnomathematics and regular instruction* was supported by the results of the statistical analysis. Repeated Measures Two way ANOVA for control and treatment groups' scores on MATT indicated that $F=8.295$ with $p=.006$. The difference between the groups is statistically significant ($p=.006$) in favor of treatment group.

Conclusion and Implications

The study showed that there were no significant effects of instruction integrated with ethnomathematics on mathematics achievement. This finding of the study contradicted with the report of Moses (2005) that African-American students' achievement scores in mathematics increased as they learn about African culture. Also the grades of algebra course of students taught ethnomathematical pedagogy were higher than the students' who receive instruction without the ethnomathematical pedagogy (Arishmendi-Pardi, 2001). Moreover, many researchers reported the superiority of integrating ethnomathematics into mathematics instruction on students' mathematics performance (e.g. Arishmendi Pardi, 2001; Lipka et. al. 2005; Brenner, 1998.). Another contradiction was found with Lipka and his colleagues (2005) findings that the results of students' mathematics performance were in favor of the instruction which is math in a cultural context and based on two case studies of a successful culturally based math project. So results of the current study about achievement levels may be questioned in terms of the time/length of the treatments or about the differentiation of the treatments.

Second finding of the study showed that instructional practices which was enriched by ethnomathematical examples effected students' attitudes towards mathematics positively in treatment group. This study provides an argument for a teaching technique, instruction integrated with ethnomathematics to improve math education. The findings suggested that, integrating ethnomathematics is an effective strategy to promote students' attitudes towards mathematics. In order to enhance self-confidence, capacity, readiness and openness to work in a multicultural environment among future math teachers Gerdes (1998) argued to develop an awareness of the social and cultural bases of mathematics.

Additionally, this study provides helpful findings on integrating ethnomathematics to mathematics lessons within a mathematics learning setting. The connection between mathematical ideas and lived experience of individual students, were emphasized in the study of Presmeg (1998) which argues that the ethnicity of students is a resource for mathematics. As Gerdes (2001) suggested teachers may look for suitable activities to create a truly simulating and enriching environment to help all students fully develop their potentials.

The ornaments in Topkapı Palace prompted students to look at the colors, shapes, and patterns in the culture and reinforced the idea that ornaments can be a means of expressing one's cultural heritage, living style, psychology and status. The exploration of different ornaments, ethnomathematical practices, tiling and patterns allows students to begin to see how cultures express themselves and realize how the mathematics that they use in school is connected with things that they see in the world. This presentation offers a few ideas for using ornaments to help students explore various cultures and mathematical concepts. These activities can be modified for use with students in other grades. As students arrange and learn the characteristics of the shapes to form the tiling, they can explore the importance of the number of sides, angles, and so forth. Teachers might also modify the lessons by searching other ethnomathematical practices.

Finally in this paper, although the influence of instruction integrated with ethnomathematics was not statistically significant, in general a potential trend showing the higher mathematics performance was observed in other researches investigating the effects of instruction integrated with ethnomathematics. This is an interesting trend deserving further research.

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