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To what extent do different multiple intelligences affect sixth grade students' achievement level on the particle model of matter?

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Abstract

In this study, multiple intelligences (MI) of sixth grade students were investigated to determine the extent to which they affect the students' achievement on the topic of the *particle model of matter*. The study was conducted with four randomly selected elementary schools with a total 132 sixth grade students in the Spring 2008 semester. Pearson correlations and ANOVA tests results revealed that there were positive low correlations between achievement and mathematical-logical, visual-spatial, and interpersonal intelligences. Also, it was found out that bodily-kinesthetic learners' achievement level were lower than mathematical-logical, visual-spatial, and musical learners. Similarly, naturalistic learners' scores were lower than the mathematical-logical and visual-spatial learners.

Keywords: Multiple Intelligence; particle model of matter; elementary education, science education.

1. Introduction

Elementary students are introduced to the concept of particulate model of matter, which is found on Turkish Science and Technology Curriculum, for the first time at the sixth grade level. This concept is one of the fundamental ideas of scientific knowledge. A meaningful learning of this concept is essential to better understanding of some other topics in physics, chemistry, biology, and earth science (Singer & Wu, 2003). However, studies indicated that elementary school students have important difficulties on understanding the concept (Singer & Wu, 2003; Merritt, Shwartz, & Krajcik, 2007; Margel, Eylon, and Scherz, 2008). It is very important to avoid these difficulties at the early stages in order to facilitate the meaningful learning and not to cause alternative ideas. One of the ways to ensure this aim is to consider the learning styles of learners who have different ways in which they prefer to learn. Gardner (1999a) claims that instructors need to be aware of the difficulties students face in understanding of topics and concepts. Therefore, instructors should consider the differences amount mind in order to reach variety of students. Similarly, Moellem (2007) stated that students' learning styles is essential in the learning process and integrating them in instruction has likely to make possible learning for students. Graf, Kinshuk, and Liu (2009) emphasized that considering students' learning styles can help in many ways to teachers in terms of

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explaining the subjects and preparing the courses. Many researchers suggest that when the learning materials and activities match students' learning preferences learning can occur more easily than learning in mismatched conditions (Pedrosa De Jesus, Almeida, & Dias, 2007).

Multiple Intelligence (MI) Theory was one of the learning style models and has been used for ensuring the effective instruction in grades K to 16. Gardner (1983) first offered the MI theory with seven different intelligences and then based on his research studies he added naturalist intelligence (Gardner, 1999b). Gardner (1983; 1999b) defines the eight intelligences as follows:

1. Logical-Mathematical Intelligence-- consists of the capacity to analyze problems logically, perform mathematical operations, and investigate issues scientifically. This intelligence is most often associated with scientific and mathematical thinking.
2. Linguistic Intelligence-- This intelligence includes the ability to effectively use language to express oneself rhetorically or poetically; and language as a means to remember information.
3. Spatial Intelligence--gives one the ability to manipulate and create mental images in order to solve problems. This intelligence is not limited to visual domains.
4. Musical Intelligence--involves skill in the performance, composition, and appreciation of musical patterns. It encompasses the capacity to recognize and compose musical pitches, tones, and rhythms.
5. Bodily-Kinesthetic Intelligence--entails the potential of using one's whole body or parts of the body to solve problems. It is the ability to use mental abilities to coordinate bodily movements.
6. Interpersonal Intelligence--ability to notice and make distinctions among other individuals and, in particular, among their moods, temperaments, motivations, and intentionsis concerned with the capacity to understand the intentions, motivations and desires of other people. It allows people to work effectively with others.
7. Intrapersonal Intelligence--ability to distinguish and identify various personal thoughts and feelings and to use them to understand one's own behavior.
8. Naturalist Intelligence - - ability to discern similarities and differences and make classifications among the living organisms in one's environment.

Multiple intelligences based teaching recognize that each student has all these intelligences, but that they are not always developed well or effectively, and individuals differ in the strengths of the intelligences so called profile of the intelligences. Therefore, it is thought that different types of multiple intelligences that students have can play an important role in affecting their achievement level in the topic. The purpose of the study was to examine the multiple intelligences (MI) of sixth grade students to asses their effect of students' achievement level on the topic of *particle model of matter*. Specifically, the research questions were:

1. What are the sixth grade students' multiple intelligences profiles?
2. Is there a significant correlation between students' multiple intelligences profiles and the students' achievement levels on the particle model of matter?
3. Are there any significant differences in the achievement level of students having one or another of the eight intelligences on the topic of the particle model of matter?

2. Method

2.1. Participants

The participants of this study were 132 sixth grade students from four elementary schools which randomly selected. The average age of the study sample was 12 years. The overall gender division of the participants was 52% (69) girls and 48% (63) boys.

2.2. Measurement Tools

Two data collection tools were used in this research; an achievement test and a multiple intelligences survey. The detailed information about each data collection tool is discussed below.

2.2.1. Achievement Test

The achievement test was developed by the researcher and administered to determine the students' achievement level on the topic of the particle model of matter. Validity was established with the assistance of two science teachers and a science education professor. These specialists' opinions were taken into consideration to ensure the content validity of 19 questions. The two science teachers currently teach 6th grade. One of them had 5 years teaching experience at the time of the study, while the other had 25 years of teaching experience, while the science professor had 35 years of teaching experience. This test was piloted on 251 sixth grade students who attended three schools different than those used in the study itself. This test was administered to all students in a 40 minute period. For the calculation of reliability of this test, an item analysis was performed by the researcher. After the pilot study, two questions that have item discrimination index values less than d <.02 were eliminated. The average item difficulty level was measured as .52; average item discrimination index .45. Item difficulty scores of the each items' ranged from .20-.78 and item discrimination index scores ranged from .21 to .69. Also, Cronbach's alpha reliability coefficient of the test was found to be .91 in the study. Thus, the post-test used to assess achievement consisted of 17 questions. In the assessment of the test results, for each correct answer in the multiple choice questions, students were awarded 1 point. Consequently, the possible achievement scores of the participants ranged from 0 to 17.

2.2.2. Multiple Intelligence Fields Determination Survey

This survey, which was suggested by Saban (2004), was applied to determine the students' multiple intelligence fields. The survey had eight areas corresponding to the different multiple intelligences with ten questions each, making 80 questions in total. The questions included items about the fields of linguistic intelligence, mathematical/logical intelligence, visual/spatial intelligence, bodily/kinestetic intelligence, musical intelligence, inter-personal intelligence, intra-personal intelligence, and naturalistic intelligence fields. For the evaluation of the test students were scored (1) if their response to an item was "very little like to me"; (2) if they responded "little like to me"; (3), for the response "somewhat like to me"; (4), for the response "like to me"; (5) for the response "a lot like to me". According to this scoring system the strengths of each students on the eight multiple intelligence fields were determined as follows: a score between 0-7 it was determined as "not developed"; between 8-15 , "less developed"; between 16-23,"average development"; between 24-31,"developed"; and between 32-40,"well developed". Cronbach's alpha reliability coefficient of the survey was recalculated as. 94 by the authors. This survey also was administered to assess the most preferred intelligence of each student within one of the eight MI fields as Al-Balhan (2006). Individuals scoring the highest in an MI field were considered to be skilled in that intelligence. If students got the same highest point more than one intelligence, these students was considered to be skilled more than one intelligence.

3. Data Analysis

The data collected by the *Multiple Intelligence Fields Determination Survey*, and achievement test were analyzed by descriptive statistics, Pearson Correlation analysis, one-way ANOVA, and post hoc tests by using the SPSS 16.00 program at .05 significance levels.

4. Results

Results are organized according to research questions of the study that were mentioned below.

4.1 Students' MI Profiles

Descriptive statistics including the mean, standard deviation, frequencies, and percentages were used in order to determine strengths of the students' multiple intelligence fields. Mean average, standard deviation, frequencies, and percentages of students' MI scores were shown in Table 1.

Table 1. Profiles of students' each multiple intelligence fields

MI	**WD**		**D**		**AD**		**LD**		**ND**		**M**	**SD**	**SMI**
	f	%	f	%	f	%	F	%	f	%			
VL	8	6.1	62	47.0	52	39.4	10	7.6	0	0	24.00	5.64	D
ML	52	39.4	53	40.2	23	17.4	4	3.0	0	0	28.50	5.92	D
VS	45	34.1	63	47.7	21	15.9	3	2.3	0	0	28.77	5.45	D

BK	46	34.8	64	48.5	16	12.1	6	4.5	0	0	28.47	5.60	D
MR	39	29.5	49	37.1	36	27.3	8	6.1	0	0	26.40	7.02	D
InterP	31	23.5	68	51.5	27	20.5	6	4.5	0	0	27.12	6.04	D
IntraP	23	17.4	68	51.5	34	25.8	7	5.3	0	0	25.80	5.81	D
N	31	23.5	60	45.5	31	23.5	7	5.3	3	2.3	25.99	7.40	D

Note: VL: Verbal/Linguistic, ML: Mathematical/Logical, VS: Visual/Spatial, BK: Bodily/Kinesthetic, MR: Musical-Rhythmic, InterP: Inter-Personal, IntraP: Intra-Personal, N: Naturalist, SMI: Strengths of MI Fields, ND: Not developed, LD: Less developed, AD: Average Developed, D: Developed, WD: Well Developed

Students' mathematical/logical (ML), visual/spatial (VS), and bodily/kinesthetic (BK) intelligences' mean average scores were higher than the other five intelligences. The lowest score of MI fields were found on the verbal/linguistic field (M=24.00, SD=5.64) and the highest score were found on the visual/spatial field (M=28.77, SD=5.45). In addition, students' strengths of each of MI fields were found on the *developed* level. Similarly, students' percentages of distribution of strengths levels generally were at the same level.

4.2. Correlations between multiple intelligence fields and achievement level on particle model of matter

The result of one-tailed Pearson correlation coefficients showed that there were a significant positive correlation between achievement level and mathematical/logical (r=.275, p=.001), visual/spatial (r=.194, p=.026), musical (r=.185, p=.036), and inter-personal (r=.177, p=.043) MI fields of students. The results can be seen in Table 2.

Table 2. Correlations between MI fields and Achievement scores of students

MI Fields	Achievement level	
	r	p
VL	.128	.142
ML	.275**	.001
VS	.194*	.026
BK	.109	.214
M	.185*	.034
InterP	.177*	.043
IntraP	.110	.210
N	.053	.545

Note: **=p<0.01, *= p<0.05

4.3. Achievement level of students having most preferred intelligence within one of the eight MI fields

A one-way ANOVA test was used to determine whether there was a statistically significant difference according to the each student's most developed intelligence on achievement scores. It was found that there was a significant difference between learners' achievement level on particle model of matter (F=2.617, p=.014) according the different multiple intelligences. ANOVA rest results on achievement level of learners who skilled diifferent <mı fields were presented in Table 3.

Table 3. ANOVA rest results on achievement level of learners who skilled different MI fields

MI field	N	M	SD	F	p
VL	6	11.83	3.43	2.617	.014
ML	31	12.61	2.95		
VS	28	11.85	3.17		
BK	26	9.53	3.47		
MR	21	11.85	3.36		
InterP	14	11.42	3.93		
IntraP	9	10.33	3.31		
N	21	9.95	3.02		

Following the ANOVA test (because of the homogeneity of the variance tests' p values >0.05) a LSD test was conducted in order to determine which groups had significant differences in terms of MI fields. The LSD test showed that; (a) achievement level of mathematical/logical learners were higher than bodily kinesthetic and naturalist learners, (b) achievement level of visual/spatial learners were higher than bodily kinesthetic and naturalist learners, (c) achievement level of musical learners were higher than bodily kinesthetic learners. ANOVA test results on achievement level of learners' were presented in Table 3.

5. Conclusions and Discussion

In this study, multiple intelligences (MI) of sixth grade students were investigated to determine the extent to which they affect the students' achievement on the topic of the *particle model of matter*. According to the statistical analysis the following conclusions can be made:

1. Students' strengths of each of multiple intelligence fields were found on developed level.
2. There was a relationship between achievement level on particle model of matter and mathematical-logical, visual-spatial, and inter-personal intelligences.
3. Students' mean average scores on the particle model of matter who have mathematical/logical, visual/spatial, and bodily/kinesthetic intelligences were higher than the other five intelligences.
4. Learners, whose developed mathematical/logical intelligences, achievement level were higher than who skilled bodily kinesthetic intelligence and naturalist intelligence. Similarly, learners, who skilled visual spatial intelligence, achievement level were higher than who skilled bodily kinesthetic intelligence and naturalist intelligence.

These results indicated that the multiple intelligences affect the sixth grade students' achievement level on the particulate model of matter topic. Therefore, it can be said that MI were not given enough attention during the instructional design process of this topic. Many learning styles can be found within one classroom (Franzoni & Assar, 2009). This study suggested that all of the learning styles should be taken into consideration equally in instruction to meet the needs of students with different types of intelligence and to provide the students with much more understanding of the particle model of matter topic in science. In addition, it should be also ensured that the learners be aware of their learning styles and explaining them their individual strengths and weaknesses can help students to develop their weaknesses (Graf, Kinshuk, & Liu, 2009).On the other hand, it is not possible, as well as not practical, for an instructor to oblige every lesson to all of the learning styles found within the classroom. Therefore, instructors can show students how to use their more developed intelligences to aid in the understanding of a subject which normally employs their weaker intelligences (Lazear, 1992).

The topic of particle model of matter should be redesign by considering all of the multiple intelligences. It can be concluded that if instructional materials about the science and technology program were prepared by integrating elements of multiple effective teaching methods, the teaching is likely to be more effective so that reach all types of learning styles.

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