Comparing Multiple Intelligences Approach with Traditional Teaching on Eight Grade Students' Achievement in and Attitudes toward Science*

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Abstract: The purpose of this study was to investigate the effects of multiple intelligences (MI) teaching approach on 8th Grade students' achievement in and attitudes toward science. This study used a pretest-posttest control group experimental design. While the experimental group (n=30) was taught a unit on acids and bases using MI teaching approach, the control group (n=30) learned the same topic with traditional teaching. The data were collected using a multiple-choice test for students' achievement in science and a Likert scale questionnaire for students' attitudes toward science. The results of statistical analysis (MANCOVA) showed that there were significant differences in favor of the students of the experimental group with respect to both achievement in and attitudes toward science. Empirical evidence indicated that compared to traditional teaching, the MI teaching approach significantly increased 8th Grade students' achievement in and attitudes toward science.

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Introduction

Since the publication of *Frames of Mind: The Theory of Multiple Intelligences* more than twenty years ago (Gardner, 1983), Multiple Intelligences (MI) theory has gained much popularity around the world. Many educators have become interested in the theory, many schools have been organized around the theory, and numerous books (e.g., Armstrong, 2000; Campbell, Campbell, & Dickinson, 1996) and journal articles have been published about the theory (e.g., Campbell, 1997; Checkley, 1997; Goodnough, 2001a,b; Hatch, 1997; Hickey, 2004; Shearer, 2004). Special sections and issues dedicated entirely to MI theory were also published in educational journals. For example, there was a special issue, entitled "Teaching for Multiple Intelligences", in Educational Leadership in 1997. Two special issues of Teachers College Record were also dedicated to MI theory and its implementations. In the summer of 1994, a special section of the *Record* included articles that a few scholars shared their own views on MI theory (Eisner, 1994; Levin, 1994; Sternberg, 1994). In that section, Gardner also responded to the three commentaries on his theory and book (Gardner, 1994). In 2004, another special issue of the *Record* as celebration of the 20th anniversary of MI theory contained papers presented at the Multiple Intelligences SIG of the annual meeting of American Educational Research Association (AERA) in 2003. All articles showed the status of MI theory among educators and researchers, and its implementations in classrooms. The difference between the two issues of the *Record* within 10 years was strong evidence of the progress of the idea of multiple intelligences around the world. This was again obvious when the researchers from Brazil, Britain, China, and Turkey participated in the panel discussion with Howard Gardner on *Multiple Intelligences in Global Perspective* at the 2006 AERA MI-SIG. The hall was packed with more than 350 attendees at 8:15 a.m. on a Saturday morning, which goes to show the extent of popularity.

Of course, the MI popularity blows one's mind! For example, in their editorial letter, entitled "Popular Theories-Unpopular Research", Flick and Lederman (2003), who are the editors of School Science and Mathematics, highlighted why popular theories in the neurosciences and psychology such as MI theory garner so much attention in education. They state "Teachers we encounter in workshops and master's courses are more likely to recognize references to "multiple intelligences" than they are to recognize references to "learning cycle" in science education or "cognitively guided instruction" in math education.” (p. 117). However, they argue that the level of discussion and implementation related to MI theory stays at a superficial level, and its advocates who use the term “MI” do not know its author or fundamental principles of the theory. They also claim that there is no research dealing with specific educational problems although there were a number of teachers and researchers who state principles of the theory as solution of those problems in classroom teaching. Hickey (2004) also point out that there are few specific examples of teachers’ use of MI theory in instructional planning in the literature, except for some descriptive studies of MI implementation at the building level. According to Hickey (2004), there is even greater lack of studies investigating the effect of MI implementation on students’ achievement and understanding in various subject matters at middle school level because some teachers believe alternative learning models are more appropriate for the early grades since students at the middle and high school levels are supposed to get serious about learning. Hickey (2004) also states “Why this should be the case-more than two decades following the general acceptance by the MI theory by the educational community- is a mystery.” (p. 78).

According to Shearer (2004), one of the most frequently asked question is, “Does MI instruction actually enhance learning and promote greater achievement by students?” With respect to science education, students’ academic achievement and attitudes are the most important concerns for school administrators, teachers, parents, students, policy makers, and government officials (Wandersee, Mintzes, & Novak, 1994). Therefore, the primary goal of a science teacher is to help students develop conceptual understandings of science and its ways of describing, predicting, explaining, and controlling natural phenomena as well as improve their students’ attitudes toward science. However, the results of the studies over the last three decades have indicated that students come to school with varying experience with, ideas about, and explanations of the natural world, and students’ attitudes toward science are not enough power to choose science fields as a career. There is a general agreement among science educators that students’ pre-conceptions generally hinder their achievement in science (e.g., Ben-Zvi, Eylon, & Silberstein, 1986; Haidar & Abraham, 1991), and the most important variable affecting students’ achievement in and attitudes toward science were the kind of science teaching they experienced (Myers & Fouts, 1992; Piburn & Baker, 1993). For example, Posner et al. (1982) propose that many misconceptions are actually generated during learning in the classroom as a product of the interaction between the students' preconceptions and teacher-initiated instruction. Thus, various teaching models, entitled "conceptual change or constructivist teaching" have been developed to promote students' conceptions of science by science educators (e.g., Posner et al., 1982; Yager, 2000). According to the constructivist view of learning, students construct their knowledge and concepts in the direction of their abilities and experiences using their existing ideas (Osborne & Wittrock, 1983). This shows that each individual has different abilities. In fact, for improving students' achievement in science, the National Research Council (NRC) (1996) emphasizes pedagogy that reaches the intellectual, emotional, and social faculties of all children.

A theoretical approach to science teaching that shows much promise for improving students' achievement in and attitudes toward science is the MI teaching approach. However, there are still no evidentiary bases to inform science education that this approach is more efficacious for teaching and learning science than the dominant style (i.e., traditional teaching) that is occurring in most school classrooms. According to Flick and Lederman (2003), the most important educational problem that is particularly serious in teaching science and math is how to transform content to meet the needs and interests of an increasingly diverse student population. In other words, the problem is how science and mathematics can be taught based on individual students' abilities or multiple intelligences. They also argue that we as researchers must learn to help teachers to strike a balance and develop educational theories that teachers consider important. There is a need to show teachers evidence that MI improves science achievement and attitudes. Therefore, this study, timely compares the MI teaching approach with the traditional teaching with respect to each of its effect on students' achievement in a unit on acids and bases, and attitudes toward science. While the MI teaching approach respects and values all sorts of innate abilities in a child, the traditional teaching narrowly focuses on those who are verbally and mathematically inclined. If we believe in the concept of "science for every child" or attempt to abide by the *No Child Left Behind* law (NCLB, 2002), then we need to decide on teaching approaches focusing on the individual abilities, needs and interests of the learner. This study takes the position that if MI is viewed both from cognitive and affective factors, then it will better serve science education. This study is an example to show educators and classroom teachers how MI reaches the learner's needs and interests with respect to developing conceptual understanding and thus achievement in science, and attitudes toward science. This overall goal motivates us to ask the following research questions:

1. *Does the MI teaching approach significantly improve 8th Grade students' achievement in science compared to traditional teaching?*
2. *Does the MI teaching approach significantly improve 8th Grade students' attitudes toward science compared to traditional teaching?*

The Potential of Multiple Intelligences Theory for Chemistry Learning

Gardner, through his research, offers a different viewpoint on the nature of intelligence. To arrive at the MI theory, Gardner studied stroke victims suffering from aphasia at the Boston University Aphasia Research Center and worked with children at Harvard's Project Zero, a laboratory designed to study the cognitive development of children (Gardner, 1999). Working with the two groups of children in two different contexts led Gardner to believe "that the human mind is better thought of as a series of relatively separate faculties, with only loose and nonpredictable relations with one another, than as a single, all-purpose machine that performs steadily at a certain horsepower, independent of content and context" (p.32). This succinct statement embodies the theory of Multiple Intelligences. This means individual faculties or frames within the human mind can be associated with a particular intelligence, the verbal-linguistic, logical-mathematical, musical, spatial-visual, bodily-kinesthetic, interpersonal, intrapersonal, and naturalistic. Without stripping cultural values, Gardner examined the individual's growth and developmental patterns for each intelligence. He connected multiple intelligences to the works of Jean Piaget (logical-mathematical and spatial-visual intelligences), Erik Erikson (development of personal intelligences), and Lev Vygotsky (developmental models of linguistic intelligence and interpersonal intelligence). Thus, to understand multiple intelligences, Gardner synthesized the extant literature from multidisciplines. MI theory is derived from the biological or neurosciences (brain development and organization), evolution, logical analysis, developmental psychology, experimental psychology, and psychometrics.

The MI theoretical criteria arising from multidisciplinary perspectives provide potential pathways to chemical learning. The theoretical criteria in the study of acids and bases using multiple intelligences will reach children in the present day classrooms, which consist of children with various abilities and talents. Ideally, from the perspective of the chemical domain, some multiple intelligences will be better for the teaching of acids and bases than others.

Method

Sample

Participants (ages 13 – 14) were from 8th Grade in a public middle school, Istanbul, Turkey. Thirty students (17 boys and 13 girls) who learned science with the traditional teaching were in the control group and 30 students (12 boys and 18 girls) who learned science with MI teaching approach were in the experimental group. The population of students was from low and middle socio-economic status homes.

Science Education in Turkey

Educational system in Turkey consists of compulsory basic education (elementary and middle schools, age 7-15; 8 years), secondary education (senior high school, age 15-18, 3 years) and higher education (universities, 18 and older). All schools throughout the country are expected to use the curricula developed and inspected by the National Ministry of Education. Science education starts in grade 4 (age 10/11) with introductions to physics, chemistry and biology concepts. The formal science concepts such as atom, molecule, heat, temperature and cell are taught at age 13-14 (grades 7 and 8). Additionally, the upper formal science lessons begin with secondary education at age 15-16 (grade 9). Teaching in middle school science in Turkey is generally traditional, which does not actively engage students in learning, and is primarily teacher-centered.

Research Design and Procedure

This study used a pretest-posttest control group experimental design (Campbell & Stanley, 1963). In this study, a total of 60 eight-grade students (ages 13-14) were randomly selected from 183 eight-grade students in a middle school in Istanbul, Turkey. Then, each of the two teaching methods was randomly assigned to the experimental and control groups. Both groups were completely intact classrooms. This study was over a 4 week period and the science classes were held three times each week according to the school timetable. One of the researchers in this study taught the experimental class and the control class. Both groups were taught a unit on acids and bases. The achievement test and attitude questionnaire (posttest) was administered immediately following the completion of the treatment, 29 days from the administration of the pretest.

The research began with an attempt to identify each student's intelligence profile with an MI survey. This survey was adapted from Armstrong's MI survey (Armstrong, 1994). Also, the researcher interviewed with regular classroom teachers (e.g., music, art, math, physical education) of the experimental group students to learn more about their individual strengths and weaknesses. The critical information of each student's abilities obtained from the survey and the teachers was efficiently used for not only developing but also implementing MI teaching activities. For example, a student who was strong in spatial-visual, interpersonal and logical-mathematical intelligences was engaged in spatial-visual, interpersonal and logical-mathematical activities during MI science lessons. However, the same student who was weak in bodily-kinesthetic and verbal-linguistic intelligences was also encouraged to participate in bodily-kinesthetic and verbal-linguistic activities. In other words, students learned the topic of acids and bases using their strength, while they were also involved in MI activities that they are weak in order to strengthen their intelligences.

Armstrong's (1994, 2000) seven-step procedure was used for creating the MI lesson plans. This seven-step procedure consists of (1) focusing on a specific objective, (2) asking key MI questions, (3) considering possibilities, (4) brainstorming, (5) selecting appropriate activities, (6) setting up a sequential plan, and (7) implementing the plan. The first six steps consist of designing a lesson plan and the seventh step focuses on implementing the plan.

Instruments

Achievement Test (AT). The AT used in this study was developed by the researchers using the 8th Grade science curriculum objectives and students' conceptions of acids and bases found in the literature. Three chemistry professors and three middle school science teachers examined each item in the AT for content validity by comparing the science course objectives with the content of the test and the test specifications. Then, the AT consisting of 26 multiple choice questions was administered to 85 8th Grade students in two different middle schools during the previous academic year. Then, AT was reduced to 20 multiple choice questions. Cronbach's alpha reliability for the AT was 0.87.

Questionnaire of Attitudes toward Science (QATS). *The* QATS consisted of 30 positive and negative items, with 'strongly agree', 'agree', 'undecided', 'disagree' and 'strongly disagree'. When we developed the QATS based on findings of our interviews with the middle school students (n=45) who were not part of this present study, we also considered pertinent attitude questionnaires in the literature (e.g., Ebenezer & Zoller, 1993; Francis & Greer, 1999; Gogolin & Swartz, 1992). The QATS was reduced to 30 items from 45 items after the five experienced science teachers and three professors of science education examined the content validity of each item, and the reliability, consisting of internal consistency and factor analysis. The QATS consisted of five Sub-scales: enjoyment of science, anxiety toward science, interest in a science career, value of science, and interest in school science. Cronbach's alpha reliability for the QATS was 0.91.

Data Analysis

The two dependent variables in this study were: "achievement in science" and "attitudes toward science". The independent variable was the type of teaching (MI teaching approach and traditional teaching). To examine whether or not there were significant differences between the control group and the experimental group on the AT and QATS posttest scores, a one-way between groups multivariate analysis of covariance (MANCOVA) was used. Students' scores on the pre-intervention administration of both AT and QATS were used as the covariates. Wilks's Lambda was used to test the difference between the two groups on the set of posttest means of achievement in and attitudes toward science.

To control for the possible inflated Type I error rates, we adopted the Bonferroni method. When the results for the dependent variables were considered separately, analysis of covariance (ANCOVA) on each dependent variable was conducted at the .025 level (.05 divided by the number of ANCOVAs conducted) as follow-up tests to the MANCOVA. The assumptions of MANCOVA and ANCOVA were first checked**.** All statistical tests of assumptions for MANCOVA, ANCOVA, and inferential statistical analyses were done by using SPSS 14.0 (Statistical Package for Social Sciences).

Results and Discussion

First, all assumption tests showed that we have not violated any assumption concerning the MANCOVA and ANCOVAs for both dependent variables. The descriptive statistics of students' pretest and adjusted posttest scores on the AT and QATS are summarized in Table 1. The results of the MANCOVA, as shown in Table 2, indicated that there was a statistically significant difference between the control and experimental groups on the combined dependent variables: Wilks' Lambda = .571; $F(2,55) = 20.682$, $p < 0.001$ with the partial eta squared value of 0.419 referring a large difference between groups on the posttest mean vectors of achievement and attitudes.

Table 1. Descriptive statistics of Students' Pretests and Adjusted Posttest Scores on achievement in science and attitudes toward science.

Dependent variable	Pretest score				Adjusted posttest score			
	Control Group		Experimental Group		Control Group		Experimental Group	
	M	SD	M	SD	M	SD	M	SD
AT	10.60	5.19	11.07	4.95	13.63	4.07	15.14	4.09
QATS	101.17	27.22	103.97	27.15	111.98	20.29	121.96	23.11

Table 2. Multivariate Analysis of Covariance (MANCOVA) Summary for Student Achievement in and Attitudes toward Science.

	Multivariate ANCOVA					
Dependent variable	Value	Exact *F*	Hypoth. *df*	Error *df*	p	η2
Posttest mean vectors of achievement and attitudes	.571	20.682	2	55	.000	.429

Achievement in Science

Table 3 summarizes the results of ANCOVA on the posttest scores of AT with students' pretest scores as the covariate.

Table 3. Comparison of Students' achievement in science (acids-bases) for MI Group and Traditional Group: Results of Analysis of Covariance (ANCOVA)

Source of Variation	SS	df	MS	F	p	η2
AT (pretest)	738.41	1	738.41	183.51	.000	.763
Treatment	33.91	1	33.91	8.43	.005	.129
Error	229.35	57	4.02			

The tabulated data indicated that there was a statistically significant difference in favor of the MI teaching approach on students' achievement in science, $F(1,57) = 8.43$, $p < 0.01$. The partial eta squared value obtained by SPSS is .129 for AT. Based on Cohen (1988) interpretation on the strength of partial eta squared values into three levels: .01 (small effect), .06 (moderate effect), and .14 (large effect) (p. 283-288, see Table 8.2.2.), this value indicated that the magnitude of differences between the experimental and control groups was close to large for students' achievement in science.

Attitudes toward Science

Table 4 summarizes the results of ANCOVA on the posttest scores of QATS with students' pretest scores as the covariate.

Table 4. Comparison of Students' Attitudes toward Science for MI Group and Traditional Group: Results of Analysis of Covariance (ANCOVA)

Source of Variation	SS	df	MS	F	p	η2
QATS (pretest)	23701.93	1	23701.93	363.18	.000	.864
Treatment	1491.19	1	1491.19	22.85	.000	.286
Error	3719.94	57	65.26			

The results of the statistical analysis indicated that there was a statistically significant difference in favor of the MI teaching approach on students' attitudes toward science, $F(1,57) = 22.85$, $p < 0.001$. The partial eta squared value obtained by SPSS was .286 for AT. This value indicated that the magnitude of differences between the experimental and control groups was large for students' attitudes toward science.

This study has first provided the comparative efficacy of the rarely unexamined MI teaching approach and traditional teaching with respect to their effects on students' achievement in and attitudes toward science. This framework and associated strategies, specially designed for teaching the topic of acids and bases, motivate middle school science teachers to adopt and or adapt the research-based MI teaching approach. Also, this study adds to the paucity of MI studies in science education.

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