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THE EFFECTS OF MULTIPLE INTELLIGENCES BASED INSTRUCTION ON STUDENTS' PHYSICS ACHIEVEMENT AND ATTITUDES

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Abstract. *The aim of this research is to examine the effects of multiple intelligences based instruction on the 9th grade students' achievements and attitude towards the Force and Motion topics in physics. The participants of this research are composed of randomly selected 95 ninth graders, who were divided into two experimental and two control classes. The experimental groups were exposed to lesson plans based on the multiple intelligences for six weeks. In the control groups, traditional instruction was conducted. Force and Motion Achievement Test, Force and Motion Attitude Scale, Revised Student Multiple Intelligences Profile Questionnaire and Students' Views about MI-based instruction Questionnaire were used as research instruments in this research. As a result of this research, it was found that multiple intelligences based instruction had a significant effect on students' achievements in the Force and Motion topics. However, multiple intelligences based instruction had any significant effect on students' attitudes towards force and motion topics. In addition, a large majority of the students in the experimental group found the courses based on multiple intelligences more enjoyable and found more instructive.*

Keywords: *force and motion, multiple intelligences, physics education.*

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Introduction

Recent studies conducted in science education have focused on identification and elimination of difficulties encountered by students in learning science in order to raise the quality of learning. Some studies have emphasized that students regard physics as a difficult subject to learn and an abstract one (Fonseca & Conboy, 1999; Ornek, Robinson & Haugan, 2008; Whitelegg & Parry, 1999). As reasons for their views, they cite the fact that they have performed many different things such as experiments, formulas, concepts, graphs and calculations at the same time while they are learning physics (Angell, Guttersrud, Henriksen & Isnes, 2004). However, one of the reasons why students have such negative opinions about physics is concerned with the methods, which teachers employ while teaching physics (Zacharia, 2003). Contemporary understanding of education requires that different characteristics of individuals be taken into consideration and that educational activities be planned in accordance with this (Rubin & Herbert, 1998). In this sense, teachers should use learning and teaching methods that take into account the individual differences of students instead of traditional teaching in order to reduce students' negative attitudes towards physics learning and increase their success. In recent years, efforts have been made to create more efficient learning environments by taking into account the effects of individual differences in learning and various teaching methods have emerged in this regard.

Gardner (1983) proposed the multiple intelligences (MI) theory in his book "Frames of Mind: The Theory of Multiple Intelligences". MI theory goes beyond the classical point of view in the theory and is defined as an individual's ability to introduce a product, which is considered worthwhile in one or more cultures, and solve a problem they encounter in their daily or professional lives effectively and efficiently (Gardner, 1983). In this sense, Gardner (1983) does not restrict individuals' capacities to their IQs only and defines seven intelligences, which he argues people possess. Moreover, Gardner also maintains that this number may be inadequate in expressing the multiplicity of human abilities (Chekley, 1997). In support of this, in an interview held by Chekley (1997) with Gardner, Gardner mentioned the existence of an eighth intelligence in his work titled "Intelligences Reframed", which was published in 1999, and he reframed the MI theory in a way that would cover this field of intelligence (Gardner, 1999). The MI defined by Gardner are as follows: verbal-linguistic intelligence, logical-mathematical intelligence, musical-rhythmic intelligence, visual-spatial intelligence, bodily-kinesthetic intelligence, interpersonal intelligence, intrapersonal intelligence, and naturalistic intelligence. Chan (2006, p.326) indicated that "Regardless of the classification, this pluralistic view of human cognitive abilities suggests that the theory of MI provides useful framework for understanding individuals' basic competencies, as well as their unique strengths".

The MI theory has become important in educational settings as it broadens the traditional view of intelligence as mainly composed of verbal-linguistic and logical-mathematical abilities (Christison, 1999). The MI, except verbal-linguistic intelligence and logical-mathematical intelligence, on the other hand, are not given proper attention or taken seriously within the educational system. Thus, many students who fail to demonstrate the traditional academic intelligences have been remaining unrealized (Campbell et al., 1996). MI theory emphasizes the importance of creating student-centered learning environments and individualizing teaching (Kagan & Kagan, 1998). Moreover, MI-based learning environments take into consideration students' different learning capacities, show them that there are various ways of being smart (Christodoulou & Kunkel, 2009) and offer to them diverse ways of learning (Haggarty, 1995). In learning environments, where students' MI are taken into consideration, students will discover their own competences and personalize information meaningfully. It is evident that the quality of learning will increase in learning environments where students' individual characteristics are taken into account (Isik & Tarim, 2009).

Chapman (1993) and Armstrong (1994) indicated that the MI theory makes great contributions to education. Moreover, they suggested that teachers need to expand their repertoire of techniques, tools and strategies beyond the typical linguistic and mathematical ones predominantly used in classrooms. MI theory may also serve as a framework for teachers to explore their teaching styles and to help them in making decisions about teaching and learning experiences for students (Goodnough, 2001). Moreover, Kagan and Kagan, (as cited in Ozdemir, Guneysu, & Tekkaya, 2006, p.74) indicate "The MI theory can be used to match teaching to how students learn, to encourage students to stretch their abilities to develop all their intelligences as fully as possible, and honor diversity". Science teachers could be able to help their students in improving their MI and enable them, by offering different ways of learning, to learn science by doing and experiencing through MI-based instruction.

To be able to enrich learning environments, it will be useful for teachers to have information about the students' MI profiles before they come to the learning environment. Based on the view that standardized measurements will measure only some of the competences, Gardner (1993) recommends that alternative testing techniques be used in the assessment of MI. However, student self-reports conducted through paper-pencil checklists are considered important sources of data in determining students' MI profiles and it is emphasized that such self-report measures can be used to identify students' MI profiles (Armstrong, 1994; Chan, 2001). Moreover, Gardner states that to measure intelligence, a separate scale needs to be developed for each intelligence and respondents need to be untroubled while they are dealing with materials and methods that measure these MI dimensions (Gardner, 1993).

When the relevant literature was reviewed, it was observed that generally validity and reliability analyses of the self-report MI measurement instruments had not been conducted. There are limited numbers of MI instruments whose validity and reliability have been reported (Shearer, 1994; Chan, 2001, 2006; Tirri & Nokelainen, 2008; McClellan & Conti, 2008; Teele, 1997). Student Multiple Intelligences Profile (SMIP-24), which was developed by Chan, (2001, 2006) was administered to 1560 Chinese primary and middle school students. According to the results of the confirmatory factor analysis, the model demonstrates good fit when the fit indices are taken into consideration. Multiple Intelligences Developmental Assessment Scale (MIDAS), which was developed by Shearer (2005), has so far been administered to 8497 students aged 9-12, 1347 college and university students and 1071 adults. As a result of the confirmatory factor analysis, model exhibited good fit. Teele Inventory of Multiple Intelligences (TIMI) (Teele, 1997) was administered from primary school level to the university level and it was stated to be reliable.

When studies concerning MI are examined, various studies that investigate students' MI profiles are encountered. In a study conducted by Uysal and Eryilmaz (2006), seventh and tenth grade students' dominant intelligences were investigated and interpersonal intelligence was found to be the dominant intelligence for both class levels. In another study conducted by Demir and Aybek (2012), on the other hand, it was found that the most dominant intelligences of ninth graders were intrapersonal, interpersonal and visual-spatial intelligences. Razak and Zaini (2014) concluded in a study they conducted that students' dominant intelligences were bodily-kinesthetic, inter-

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personal, visual-spatial and musical-rhythmic intelligences. Moreover, Ozdemir et al., (2006) stated that fourth grade students' dominant intelligences were logical-mathematical, visual-spatial and interpersonal intelligences.

Some researches indicated the positive evidences of MI-based instruction for the academic achievement and attitudinal behaviors of the students at high school. The MI theory used in the educational settings increases students' attitudinal behaviors (Campbell, 1992). Moreover, The MI theory improves students' learning quality (Campbell, 1992). The Project Zero research group founded by Howard Gardner conducted a study entitled Schools Using Multiple Intelligence Theory (SUMIT) to determine the benefits of MI for students at schools. According to the results of this longitudinal study, which was implemented in 41 schools that had been carrying out MI-based instruction for at least three or four years, standard test achievements of the students of 80% of the schools improved and they developed positive attitudes (Kornhaber, Fierros & Veenema, 2004). Today, some of the schools (e.g. The Key School in Indianapolis, The Matter School in Boston) have based their curricula entirely on MI theory owing to these positive aspects of the MI theory (Blythe & Gardner, 1990; Hatch, 1993; Hoerr, 1994). In addition, as far as the Turkish Education System is concerned, both the science curriculum and the physics curriculum 2007 emphasize the importance of the use of various active learning methods, notably the MI theory, which considers individual differences and enables construction of knowledge (MNE, 2007, 2013).

When studies investigating the effects of MI-based instruction on students' achievements and attitudes were examined, it was found that these studies involved science such as biology and chemistry and mathematics. However, there is limited number of experimental studies investigating whether or not MI-based instruction had a significant effect on students' achievements and attitudes towards chemistry, biology and mathematics (Dillihunt & Tyler, 2006; Ozdemir et al., 2006; Ucak, Bag & Usak, 2006; Isik & Tarim, 2009). In addition, studies that investigated the effects of MI-based instruction on students' achievements and attitudes towards physics have been also found to be limited (Gurcay & Eryilmaz, 2005).

The aim of this research is to examine whether or not the MI-based instruction has a significant effect on 9th grade students' achievements in and attitudes towards the force and motion concepts in the physics course in comparison with the traditional instruction. For this purpose, answers were sought to the following questions:

1. Is there a significant effect of MI-based instruction on 9th grade students' achievements in the force and motion?
2. Is there a significant effect of MI-based instruction on 9th grade students' attitudes towards the force and motion?
3. Is there a significant difference in the experimental and control groups' MI scores before and after the intervention?
4. What are the students' views concerning MI-based instruction?

Methodology of Research

General Background

Quasi-experimental pre-test, post-test control group design was used in this research. Since it was impossible to assign the students in the experimental and control groups in the two schools randomly to classes, this research is quasi-experimental (Shadish, Cook & Campbell, 2002). Therefore, this research was conducted in 2013-2014 academic year, with four classes from two schools, 2 were experimental classes with MI based instruction and two were control classes with traditional instruction, to elicit the effects of MI based instruction on students' achievement and attitudes. Moreover, it lasted 8 weeks, as a week pre-test, six-weeks treatment and a week post-test.

Sample

The participants of this research are comprised of 9th grade students attending two primary schools in Ankara-Turkey. Four classes, one experimental group and one control group from each school, were assigned randomly. Ninety-five students, 50 in the control group and 45 in the experimental group, participated in this research. The proportion of male (53.7) and female students (46.3) was at about the same level. Most of the students (68.4 %) were aged 15, 16.8 % were aged 16 and 14.7 % were aged 14. All of the subjects voluntarily participated in this research. Before the research, they are informed about the research methodology. They fulfilled the consent form and their names are kept anonymous.

Instruments and Procedures

In order to collect the data in this research, Force and Motion Achievement Test (FMAT), Force and Motion Attitude Scale (FMAS), Revised Student Multiple Intelligences Profile Questionnaire (SMIP-24) and Students' Views about MI-based instruction Questionnaire (SVQ) were used.

Force and Motion Achievement Test (FMAT)

This test was developed by the researchers to measure the ninth grade students' achievement in the force and motion concepts. The topics covered in this test involved motion in one dimension, classification of motion, position, distance, displacement, velocity, speed, linear motion, acceleration, force, friction and Newton's laws of motion, which had to be taught according to the ninth grade curriculum. In order to develop FMAT, first objectives of the ninth grade were taken into consideration and 47 multiple choice questions with five choices were developed. The questions in the test were taken from the physics books and university entrance examinations administered in Turkey. For the content validity of the test, an expert in physics education, a physics professor and a physics teacher checked whether the test items matched students' levels, the physics curriculum and then necessary changes were made. Furthermore, at the end of this process, test items were administered to five ninth grade students; feedback about to what extent the items were understood was obtained and necessary changes were performed.

The pilot study of the test was conducted on 124 students at 9th grade. As a result of the item validity analysis and reliability analysis, 22 items were removed from the test, taking into consideration the item difficulty, reliability and discrimination index and thus the final test have 25 items. Items whose item discrimination index is below .30 should be removed from the test (Ding, Chabay, Sherwood & Beichner, 2006). Therefore, the items in this test whose item discrimination indices were below .30 were removed. As a result of this pilot study, the average item difficulty of the 25-item FMAT was calculated to be .50, whereas its item discrimination index was .40 and Cronbach Alpha reliability coefficient was .73. The minimum score that could be taken from the test was 0 while the maximum score was 25. The students were given a class hour (40 minutes) to answer the test. FMAT was administered to the experimental and control groups as pre-test and post-test. The Cronbach Alpha reliability coefficient calculated as .78 for the pre-test scores and .81 for the post-test scores of FMAT.

Force and Motion Attitude Scale (FMAS)

In order to measure the ninth grade students' attitudes towards the force and motion FMAS was used. This scale was developed by Taslidere (2012) in order to measure students' attitudes towards simple electric circuits. However, he stated that this scale could be used to measure students' attitudes toward other physics topics since it is a content based scale. Therefore, we made wording on the original scale. FMAS is a 5-point Likert scale consisting of 24 items that involves the following statements: "I totally agree, I agree, I am undecided, I disagree and I totally disagree". The scores that could be received from FMAS vary between 24 and 120. Taslidere (2012) determined the Cronbach Alpha reliability coefficient of the scale as .93. On the other hand, Cronbach Alpha reliability coefficients of FMAS were calculated for its pilot-, pre-test-, and post-test administrations as .92.

Revised Student Multiple Intelligences Profile Questionnaire (SMIP-24)

In this research, SMIP-24, developed and then revised by Chan (2001; 2006), was used to determine students' MI dimensions. First, MI scales developed by various researchers were examined, taking into account criteria such as validity and reliability analyses, item numbers in the scale and their conformity with students' readiness (Shearer, 1994; Teele, 1997; Chan, 2006; Tirri & Nokelainen, 2008; McClellan & Conti 2008). Then it was decided that SMIP-24 (Chan, 2006) be used. SMIP-24 is a 24-item self-report questionnaire consisting of three items for each of the eight MI dimensions. Participants responded themselves using a five-point scale ranging from zero (least descriptive) to five (most descriptive). The lowest score that could be taken for each MI dimension was zero while the highest score was 15.

Within the scope of this research, first SMIP-24 was adapted to Turkish. For this purpose, two experts in English translated English version of the questionnaire into Turkish. During the process of translation, special attention was paid to conceptual, idiomatic and field correspondence. Following the completion of the translation process,

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a language expert was consulted and then another English expert was asked to analyze the questionnaire in terms of grammar and translate the questionnaire items back into English, the source language. It was determined subsequent to the translation practices that there were no meaning changes or meaning losses. After the completion of the translation process, assistance was received from two experts in Turkish language and literature department to test the conformity of the questionnaire with Turkish. Vocabulary changes suggested by the experts were made. A group of five students read the questionnaire items and they were asked if the items were comprehensible. Then, the pilot study of SMIP-24 was carried out with 432 students attending 9th grade. The students were given 25 minutes to answer the test. Confirmatory factor analysis was performed in the study conducted by Chan (2006) to test the construct validity of SMIP-24. The fit indices belonging to the model are given in Table 1.

Table 1. Fit indices of SMIP-24 (Chan, 2006).

χ^2/df	RMSEA	CFI	S-RMR	GFI	ECVI	df
3.25	.056	.909	.044	.935	1.204	448

In this research, Confirmatory Factor Analysis (CFA) was performed to determine the construct validity of SMIP-24 through the pilot study. The fit indices calculated are given in Table 2. When Table 2 was investigated, fit statistics in general were similar with the original SMIP-24 questionnaire and acceptable for the model fit. Normed chi-square value less than 5 indicates an acceptable fit between a hypothesized model and sample data (Schumacker & Lomax, 2004). The Standardized Root Mean Square Residuals (SRMR) value less than .1 and the Root Mean Squared Error of Approximation (RMSEA) value less than .08 regarded as acceptable fit (Browne & Cudeck, 1993). Comparative Fit Index (CFI) and Goodness of Fit Index (GFI) values are regarded acceptable if they are greater than 0.9 (Bentler 1995). Generally, fit indices of this research revealed that there is a good model fit. In addition, it has been stated that when the CFI value is .85 and above, it is acceptable (Bollen, 1989). Therefore, in this research CFI value shows a reasonable fit.

Table 2. Fit indices of the pilot study.

χ^2/df	RMSEA	CFI	S-RMR	GFI	ECVI	df
2.19	.056	.880	.063	.900	1.710	222

Cronbach Alpha was calculated for each MI dimension to determine the internal consistency coefficient of SMIP-24. Cronbach Alpha coefficients calculated by Chan (2006) were as follows: for verbal-linguistic intelligence .61, for logical-mathematical intelligence .60, for visual-spatial intelligence .61, for bodily-kinesthetic intelligence .67, for intrapersonal intelligence .73, for interpersonal intelligence .72, for musical-rhythmic intelligence .76, and for naturalistic intelligence .77. In the pilot study of the questionnaire, the Cronbach Alpha coefficients of the MI dimensions were .65 for the verbal-linguistic intelligence, .66 for the logical-mathematical intelligence, .70 for the visual-spatial intelligence, .74 for the bodily-kinesthetic intelligence, .75 for the intrapersonal intelligence, .78 for the interpersonal intelligence,.73 for the musical-rhythmic intelligence, and .80 for the naturalistic intelligence. In this research, on the other hand, Cronbach Alpha coefficients for each MI dimensions were as follows: .55 for the verbal-linguistic intelligence, .61 for the logical-mathematical intelligence, .63 for the visual-spatial intelligence, .74 for the bodily-kinesthetic intelligence, .75 for the intrapersonal intelligence, .75 for the interpersonal intelligence, .73 for the musical-rhythmic intelligence, and .80 for the naturalistic intelligence.

Students' Views about MI-Based Instruction Questionnaire (SVQ)

At the end of the treatment, five open-ended questions were prepared by the researchers to determine the students' views concerning MI-based instruction. At the end of the treatment, only the students in the experimental group were asked to respond in writing to the questions on the SVQ. Response format was open-ended. The questions on the questionnaire were as follows: "Your physics classes have been conducted according to the MI-based instruction. What would you say about these physics classes compared with your previous physics classes?", "Are there any aspects which you find inadequate concerning the way your physics classes are being taught?", "Would you like your physics classes to continue to be conducted according to MI-based instruction?", "What could be the advantages and disadvantages of your physics classes being taught according to the MI-based instruction?", "What aspects of you has the implementation of your physics classes according to the MI-based instruction improved?"

Treatment

At first, in this quasi-experimental pre-test-post-test control group research, the experimental and control groups were given the pre-tests. After the pre-tests, the experimental groups were exposed to the treatment, and then all the groups were given the post-tests. Before the treatment, all of the classes were given the FMAS, FMAT and SMIP-24 as pre-tests. After the pre-tests, the students in the experimental group were exposed to the MI-based instruction for six weeks. Meanwhile, the control groups were exposed to the traditional teaching method. The students in the control group were taught the force and motion in the physics course through techniques such as direct teaching, discussion and question-answer for six weeks. No materials other than course books and notebooks were used in control group classes. These classes were taught by the teacher. Moreover, students, listened to the teacher and asked questions when they did not understand a subject. In addition, homework was assigned after the courses. Then the same tests were administered as post-tests to all of the classes. Furthermore, SVQ was administered to the experimental group after the treatment. Thus, this research lasted 8 weeks, as a week pre-test, six-week treatment and a week post-test.

The students in the experimental group were exposed to MI-based lesson plans developed by the researcher. The MI-based lesson plans, handouts, materials and teachers' guidebook were prepared from the books of different researchers (Bellanca, 1997; Campbell & Campbell, 1999; Dillihunt & Tyler 2006). Objectives for the force and motion unit included in the ninth grade curriculum in Turkey were taken into consideration in the lesson plans. In every course, the activities intended to reach diverse MI dimensions. Table 3 shows MI dimensions intended to be covered every week through activities. The activities in MI lesson plans were selected and prepared among the activities given by Dillihunt and Tyler (2006). Before the implementation of the MI-based lesson plans, views of two field experts and two physics teachers were taken concerning the compatibility of the activities with the curriculum, their compatibility with the relevant intelligence dimension and with the students' level of readiness. Necessary changes were made based on experts' views.

Table 3. Targeted MI dimensions in the activities.

Weeks	MI Dimensions Used in Lesson Plans
1st week	Verbal-Linguistic, Logical-Mathematical, Visual-Spatial, Intrapersonal, Interpersonal, Musical-Rhythmic
2nd week	Verbal-Linguistic, Logical-Mathematical, Visual-Spatial, Intrapersonal, Interpersonal
3rd week	Verbal-Linguistic, Visual-Spatial, Bodily-Kinesthetic, Intrapersonal, Interpersonal, Naturalistic
4th week	Verbal-Linguistic, Logical-Mathematical, Visual-Spatial, Bodily-Kinesthetic, Intrapersonal
5th week	Verbal-Linguistic, Logical-Mathematical, Visual-Spatial, Bodily-Kinesthetic Intrapersonal, Interpersonal, Naturalistic,
6th week	Verbal-Linguistic, Logical-Mathematical, Visual-Spatial, Intrapersonal, Interpersonal Musical-Rhythmic,

During implementation of the MI-based lesson plans, the students in the experimental group were given activities of MI dimensions. All the students performed the activities at the same time and at the end of the activities shared their performance with their friends. The activities were prepared in such a way as to allow students to participate actively and engage in group work. Moreover, students were assigned homework covering various MI dimensions at the end of the classes. Table 4 shows examples of activities given in the activities concerning each MI dimension:

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Table 4. MI related activities in the lesson plans.

Verbal-Linguistic Intelligence Activities:	Discussions, dialogues, word games, poetry, storytelling, reading, oral presentations
Logical-Mathematical Intelligence Activities:	Socrating questioning, scientific investigations, problem solving, logical-sequential assignments
Visual-Spatial Intelligence Activities:	Graphic rich environments (visual and graphic organizers, pictures, posters, charts, graphs, diagrams)
Bodily-Kinesthetic Intelligence Activities:	Role plays, creative movement (mime, dance, drama, table techniques –body used to communicate)
Intrapersonal Intelligence Activities:	Reflection time/opportunity (journals), independent instructional assignments
Interpersonal Intelligence Activities:	Social cooperative learning, opportunity to help others
Musical-Rhythmic Intelligence Activities:	Curriculum songs (creating melodies, songs, rap, cheers, jingles etc.), poetry, poems
Naturalistic Intelligence Activities:	Environmental issues, outdoor activities

Data Analysis

Multivariate statistical analysis (MANCOVA) and descriptive analyses were conducted to examine whether or not MI-based instruction had a significant effect on students' achievements in and attitudes towards the force and motion unit, when the FMAT- and FMAS- pre-test scores were taken under control. Before the MANCOVA analysis, assumptions of MANCOVA were checked.

Results of Research

Table 5 shows results of the FMAT pre-test, post-test descriptive statistics of experimental and control groups. An increase of 3.42 points is observed between the pre-test and post-test scores of the experimental group (Table 5). On the other hand, there is an increase of 1.7 points between the pre-test and post-test scores of the control group. This increase is lower than the increase achieved in the experimental group.

Table 5. Results of FMAT descriptive statistics.

	Experimental Group		Control Group	
FMAT	Pre-test	Post-test	Pre-test	Post-test
Mean	14.91	18.33	14.76	16.46
Standard Deviation	4.41	3.46	4.27	4.75
N	45	45	50	50

Table 6 shows results of the FMAS pre-test and post-test descriptive statistics of the experimental and control groups. An increase of 4.17 points is observed between the pre-test and post-test scores of the experimental group (Table 6). However, an increase of 3.34 points is seen between the pre-test and post-test scores of the control group. This increase is lower than the increase achieved in the experimental group.

Table 6. Results of FMAS descriptive statistics.

	Experimental Group		Control Group	
FMAS	Pre-test	Post-test	Pre-test	Post-test
Mean	80.47	84.64	77.98	81,32
Standard Deviation	17.41	17.68	15.13	14.57
N	45	45	50	50

The students' MI pre-test and post-test scores in the experimental group are given in Figure 1. As a result of the t-test, significant increases were observed in the students' musical-rhythmic intelligence (p= .000), bodily-kinesthetic intelligence (p= .014) and naturalistic intelligence (p= .013) pre-test-post-test scores (p< .05). There was not any significant difference between pre-test and post-test scores for the other MI dimensions. Moreover, in Table 1, it is seen that MI-based instruction improved students' all MI scores. The highest increase was observed in the students' musical-rhythmic intelligence scores, whereas the lowest increase was observed in the interpersonal intelligence scores.

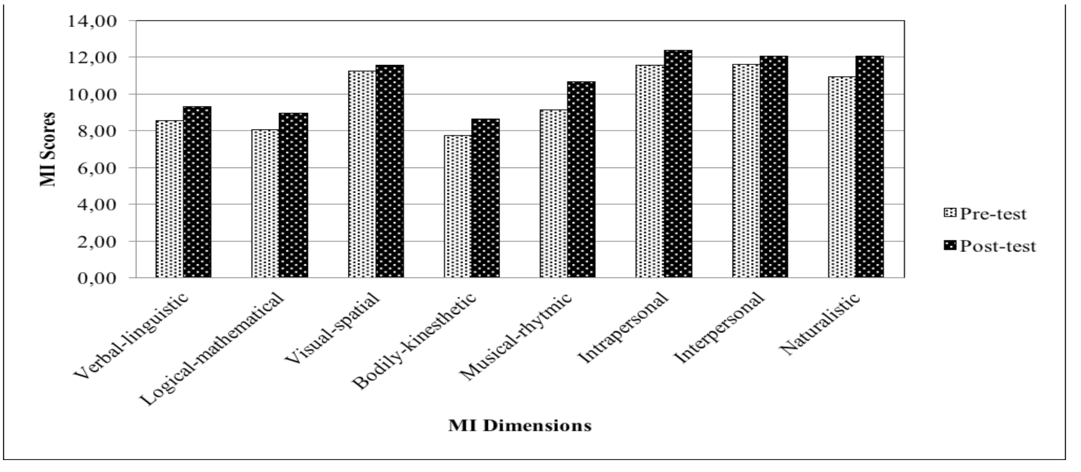

Figure 1: Experimental group students' pre-test-post-test MI scores.

The students' MI dimensions pre-test and post-test scores in the control group are given in Figure 2. As a result of the t-test, a significant increase was not observed between the pre-test and post-test MI scores of the students in the control group concerning each intelligence area. Moreover, according to Figure 2, an increase is observed in the verbal-linguistic, logical-mathematical, visual-spatial, bodily-kinesthetic, musical-rhythmic and intrapersonal intelligence scores of the students in the control group, where classes were taught using traditional teaching techniques. A decrease is observed in the average interpersonal intelligence pre-test scores, but no changes are observed in the average naturalistic intelligence scores.

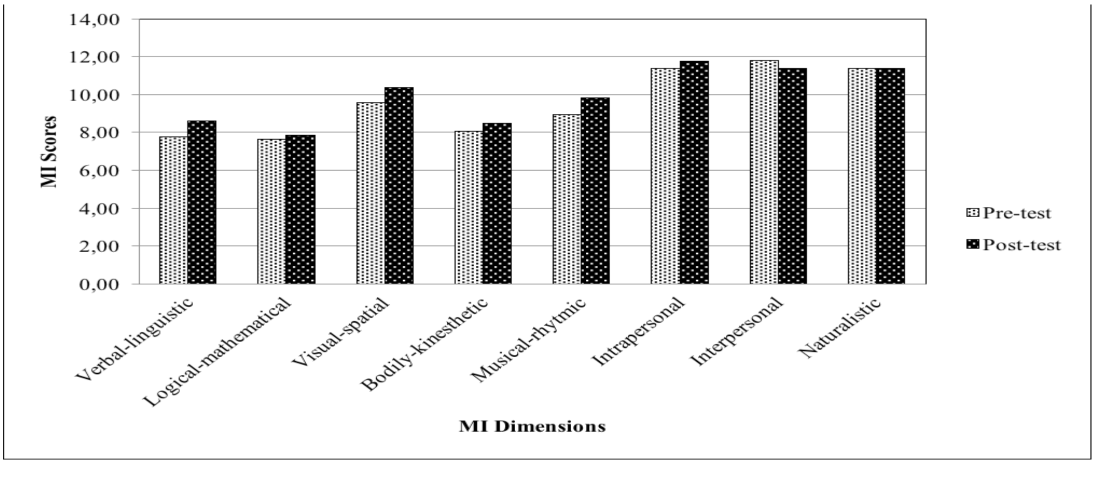

Figure 2: Control group students' pre-test-post-test MI scores

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MANCOVA Results

Since there was not any missing data, missing data analysis was not performed. Assumptions of independence of observations, normality, multicollinearity, equality of variances, and homogeneity of regressions were tested and verified for MANCOVA analysis.

In this research, the instruction method FMAT pre-test scores and FMAS pre-test scores were independent variables, whereas FMAT post-test and FMAS post-test scores were dependent variables. FMAT pre-test scores and FMAS post-test scores were used as covariates to statistically equalize the differences between the experimental and control groups. According to the multivariate test results, null hypothesis was rejected (l= 0.912; df= 90; F= 4.35; p= .016). This means, there is a significant mean difference between MI-based instruction and traditional instruction on the collective dependent variables of FMAT post-test and FMAS post-test scores. Follow-up analyses are necessary to determine which dependent variable is responsible for the variance. To test the effect of "method" on each dependent variable, a univariate analysis of covariance (ANCOVA) was conducted as follow-up test. The results showed a statistically significant effect of the "method" on the FMAT post-test (F= 8.29; df= 1; p= .005) and statistically no significant effect of the "method" on the FMAS post-test (F= .409; df= 1; p= .52).

Students' Views about MI Based Instruction Questionnaire (SVQ)

When students were asked to compare the classes conducted the MI-based instruction with their previous classes, 57.7 % of the students in the experimental group stated that the classes conducted the MI-based instruction were both enjoyable and instructive. 20 % of the students responded to the same question saying that they understood the subjects better in this way. When the students were asked if there were any shortcomings with regard to the implementation of the classes, 84.4 % of the students stated that there were no shortcomings. Moreover, when they were asked whether they wanted their classes to continue through practices based on the MI dimensions, 97.7 % of the students stated that they wanted to continue their classes in this way. When they were asked if experimental classes had any disadvantages, 84.4 % of the students responded that they did not notice any disadvantages. 60 % of the students stated that they found the classes both comprehensible and enjoyable while 31.1 % of them emphasized, that handouts were useful because they increased their participation in the classes and added that these were advantages of the implementation. Finally, when the students were asked what aspects of them improved in the experimental classes, 24.4 % of the students responded that it helped them understand the subjects better. 15.5 % responded that it improved their problem solving skills and 13.3 % stated that it raised their interest in the classes.

Discussion

According to the MANCOVA results of this research, MI-based instruction has a significant effect on the students' achievements in force and motion topics. This result supports the results of other studies. The effect of MI-based instruction on high school ninth grade students' achievements and attitudes towards physics was also investigated by Gurcay and Eryilmaz (2005) and according to the findings of the research, MI-based instruction had a significant effect on high school first year students' achievements in physics but that it did not have a significant effect on their attitudes. Moreover, Ozdemir et al., (2006) also investigated the effect of MI-based instruction, compared with the traditional instruction, on fourth grade students' achievements in Diversity of Living Things Concepts and their retention of knowledge and found that it had a significant effect on both their achievements and their retention of knowledge. Dillihunt and Tyler (2006) stated that MI-based instruction increased fifth grade students' mathematics achievements significantly. Likewise, Douglas, Burton and Reese-Durham (2008) found that MI-based instruction had a significant effect on eighth grade students' mathematics achievements compared with the direct instruction. In addition, Campbell and Campbell (1999) emphasized based on the studies they conducted, that the achievement scores in reading, language, mathematics, science and social studies had improved significantly.

Although the results of the studies mentioned above belong to different disciplines and different age groups, they support the results of this research related to the student achievements. In another study, Ucak et al. (2006) investigated if there was a significant difference between MI-based instruction and traditional instruction on the seventh graders' understanding and attitudes towards "The Structure of Material and Its Transformation". The results of Ucak et al. (2006)'s study, in which a 4-week treatment was conducted, indicated that MI-based instruction had a significant effect both on students' achievements and on the improvement of their attitudes. The results of our research do not support Ucak et al. (2006)'s results concerning attitude. This is thought to have stemmed from the sample selected. The other reason of this might be due to inadequacy of the duration of intervention. Although, it was determined that most of the students in the experimental group had positive thoughts about MI based instruction, in this study no significant difference in students' attitudes towards physics was determined compared to traditional learning. Therefore, it could also be thought that 6-week research period might not be enough to observe significant change in order that the positive opinions of the students to change their attitudes towards physics learning in a significant way. Research results show that, more time is needed for students' thoughts to lead a change in their behaviors since there are many variables that are in relation with the development of positive attitudes (Wilkins & Ma, 2010).

Goodnough (2001) reported, as a result of her qualitative research, that most students (85%) enjoyed using MI-based instruction and they liked working collaboratively with others on projects. Moreover, most of the students implied that MI-based instruction helped them to enjoy science more. These results also support the results of this research. The students in the experimental group (60%) reported that they learned physics and enjoyed physics. Moreover, majority of the students were in favor of the MI-based instruction. In MI based learning environments, the students had the chance to learn physics by using their strong intelligence. Moreover, they also had the chance to learn physics in a variety of ways. They also actively participated in the learning process. Because of that reason students might have positive views about MI based learning environments.

In this research, students' MI dimensions with the lowest mean scores were logical-mathematical intelligence, verbal-linguistic intelligence and musical-rhythmic intelligence in both the experimental and the control groups before and after the treatment. On the other hand, intrapersonal intelligence, interpersonal intelligence and naturalistic intelligence were found as the dominant intelligences. The findings of this research bear similarity to the results of various studies in the literature. In Chan's (2001) study, which was conducted on 192 students ranging from the seventh grade to the 12th grade, MI dimensions with the highest mean scores were interpersonal intelligence and intrapersonal intelligence, whereas the intelligence dimension with the lowest mean scores were verbal-linguistic intelligence, bodily-kinesthetic and visual-spatial intelligence. When studies concerning MI are examined, research results show that students' dominant intelligence is interpersonal intelligence (Demir & Aybek, 2012; Razak & Zaini, 2014; Ozdemir et al.; 2006, Uysal & Eryilmaz, 2006). However, students with strong logical-mathematical intelligence and verbal-linguistic intelligence at schools are regarded as having an advantage over others, whereas those who are weak in these MI dimensions are regarded as disadvantaged. The results of this research show that most of the students were disadvantaged in schools.

Moreover, according to the results of this research, a significant difference was observed between the musical-rhythmical intelligence, bodily-kinesthetic intelligence and naturalistic intelligence pre-test and post-test scores of the students in the experimental group. However, it was seen that there was no significant increase in the MI dimensions pre-test and post-test scores of the students in the control group. A study conducted by Ozdemir et al., (2006) also demonstrated that MI-based instruction strengthened students' multiple intelligences. It was stated that the intelligence where the most variation was observed was the musical-rhythmic intelligence area and that according to the t-test results, a significant increase occurred between the pre-test and post-test results in the students' musical-rhythmic intelligence scores (Ozdemir et al., 2006). Physics classes, in particular, are conducted in traditional classes through activities of logical-mathematical intelligence and verbal-linguistic intelligence (Christison, 1999). This means that the students are exposed to the activities of their weak intelligence dimensions. Yet, through MI-based instruction, improvements can be made in MI dimensions where students are weak and at the same time, the quality of their learning can be raised through activities in intelligence where they are strong so that more enjoyable classes can be achieved (Gardner, 1989; Goodnough, 2001; Gurcay & Eryilmaz, 2005).

Conclusion and Implications

The results of this research indicate that MI-based learning environment has a significant effect, compared with the traditional instruction, on the improvement of students' academic achievements but that it does not have a significant effect on their attitudes. A majority of the students in the experimental group stated that their interest and achievement in the physics classes increased and added that they found MI-based physics instruction more enjoyable and instructive.

Teachers need to know their students' individual characteristics and create learning environments suiting

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them. Moreover, teachers should be aware that all children have strengths. By the help of MI theory, teachers can incorporate all types of the intelligences in teaching and learning. If teachers use the MI-based instruction, students could reveal their strengths to show what they have learned. Moreover, valid and reliable self-report checklists, whose validity and profiles can help teachers to see their students' strong and weak intelligences. Due to the fact, that the number of studies conducted in physics and other branches of science concerning the effects of MI-based instruction is limited, there is a need for qualitative and quantitative studies that will be carried out on larger samples.

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