The Effects of Implementation of the Multiple Intelligences Theory on Grade-7 Students' Attitudes toward and Perceptions of Science*

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Abstract: The purpose of this study was to investigate the effects of implementation of student-centered activities based on multiple intelligences (MI) theory on grade-7 students' attitudes toward and perceptions of science. While the experimental group consisting of 25 students was taught a unit on the atom and atomic properties using strategies based on multiple intelligences theory, the control group with an equal number of students learned the same topic using traditional approaches. A 19-item Likert scale questionnaire involving "attitudes toward science" and "perceptions of science" (QAPS) was administrated to both experimental and control groups as pretest and posttest. The results of statistical analysis (MANCOVA) on the posttest scores indicated that there were significant differences favoring the experimental group with respect to students' attitudes toward and perceptions of science. Also, chi-square analyses for each item in the QAPS at the end of the study showed that there were significant differences favoring students in the experimental group based on 5 items. Hence, it is concluded that strategies founded on MI theory are more effective in improving students' attitudes toward and perceptions of science than traditional teaching.

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Attitude toward Science

Attitude toward science refers to a person's positive or negative response to the enterprise of science or whether a person likes or dislikes science (Simpson, Koballa, Oliver, & Crawley, 1994). Science educators agree that the development of positive attitudes toward science is a critical component of science teaching (Aiken & Aiken, 1969; Chiappetta, Waxman & Sethna, 1990; Koballa, 1988: Laforgia, 1988). Numerous studies have been conducted on the relationships between students' attitudes toward science and several variables such as achievement (Gardner, 1975; Schibeci, 1984); gender (Simpson & Oliver, 1985); grade level (James & Smith, 1985; Yager & Yager, 1985); curriculum materials and instructional strategies (Chiappetta, Waxman, & Sethna, 1990; Ebenezer & Zoller, 1993).

The relationship between attitudes toward science and achievement in science has traditionally been the focus of science educators' research (Schibeci, 1984). While Gardner's literature review in 1975 indicated that there is some positive relationship between attitudes and achievement, nearly ten years later, Schibeci (1984) observed that the relationship between the two variables grew stronger. On the contrary, there is much less agreement between gender differences and attitudes toward science. The majority of studies demonstrate that boys have more positive attitudes toward science than girls (Fleming & Malone, 1983; Shymansky, Hedges, & Woodworth, 1990; Simpson & Oliver 1985). However, the grade level is an important variable influencing the relationship between students' attitudes toward science and gender. For example, Fleming and Malone (1983) found that boys showed a more positive attitude towards science than girls at the elementary level. In contrast to the foregoing study, these authors noted that middle school girls had a more positive attitude toward science than boys. Simpson and Oliver (1985) showed that males had significantly more positive attitudes toward science than females in grades 6 through 10, except for grade 9.

The issue of the relationship between age and attitude toward science has been also a focus of several studies. According to Yager and Yager (1985), there was an obvious decline in attitudes toward science among many students, beginning in the intermediate grades. Similarly, the findings of James and Smith's study in 1985 of grade 4 through 12 showed that positive attitudes toward science decreased sharply at seventh grade. Likewise, Morrell and Lederman (1998) pointed out that fifth graders held significantly more positive attitudes toward science than upper-grade students. Also, Schibeci (1984) noticed a general deterioration in attitudes toward science with increasing grade level. All of the foregoing studies clearly reveal that attitude toward science decreases with increase in age.

Several studies also focus on students' attitudes and the use of science curriculum materials. Interestingly, these studies indicate that the effect of a new curriculum on students' attitudes toward science is relatively small (Simpson, Koballa, Oliver, & Crawley, 1994). For example, Ebenezer and Zoller (1993) point out that a newly developed science-technology-society (STS) course in British Columbia during 1986-1989 did not affect positive changes on students' attitudes toward science.

Perception toward Science

Perception toward science refers to the degree of a person's understanding related to the nature of science and the importance of science to society. In a study conducted by two science teachers on the effect of a new physical science resource manual, *Ideas and Attitudes for Physical Science*, developed by the National Science Foundation on ninth-grade students' attitudes toward and perceptions of science, mixed results were obtained (Chiappetta, Waxman, & Sethna, 1990). The students in the experimental class of one of these teachers had more positive attitudes toward and perceptions of science than the students of the control group after a period of 6 weeks. The other teacher's experimental students barely exhibited more positive attitudes toward and perceptions of science than the students of the control group, although the study was 12 weeks long. Shepardson and Pizzini (1993) investigated the differences in middle school students' perceptions of science activities among three instructional approaches, namely, lecture worksheet, traditional laboratory, and SSCS problem solving. The results of their 8-item Likert scale indicated that these instructional approaches had different effects on the different items of the questionnaire. Their 1994 study in the grade 7-8 students revealed that the students in SSCS problem solving group exhibited more positive perceptions toward the science activities than students in traditional laboratory and textbook-based instruction. In line with these studies on the relationship between students' attitudes and perceptions and new instructional approaches, our study aimed to examine the effects of student-centered activities based on multiple intelligences theory on grade-7 students' attitudes toward and perceptions of science. Thus the following research questions formed the basis of this study:

1. Do the student-centered activities based on multiple intelligences theory significantly improve students' attitudes toward science in grade 7 compared to traditional teaching?

2. Do the student-centered activities based on multiple intelligences theory significantly improve students' perceptions of science in grade 7 compared to traditional teaching?

Methods

Participants

A total of 50 grade 7 students, ages 13-14, enrolled in a middle school in Ankara, Turkey, during the first semester of 2000-2001 academic year were randomly selected. Twenty-five students (13 boys and 12 girls) were in the control group and 25 students (16 boys and 9 girls) were in the experimental group.

Procedures

This 4-week long study involved pretest-posttest control group design (Campbell & Stanley, 1963). The science classes met three times each week for the science lesson. The attitude and perception questionnaire (posttest) was administrated immediately following the completion of the treatments, 25 days from the administration of the pretest. Both groups were taught a unit on the atom and atomic properties. The same handouts developed by the researcher, particularly for overcoming several alternative conceptions were distributed to both groups. The same teaching objectives were also outlined for both experimental and control groups. However, the experimental group was taught with student-centered activities founded on the eight intelligences of the multiple intelligences theory. And all documents of the students were individually collected in their individual portfolios. The control group also engaged in two of the eight multiple intelligences, namely, verbal-linguistic and logical-mathematical. However, these activities did not involve student-centered teaching.

The unit on atom and atomic properties consisted of eleven parts: matter and properties of matter, compound, mixture and element, atom, atomic structure, size of atoms, weight of atoms, motions of atoms, spaces among atoms, the limits of atom models, shape of atoms and living of atoms. We selected these subtopics based on the middle school curriculum, and students' alternative conceptions of atom and atomic properties based on our individual interviews conducted with middle school students during the previous academic year and science education literature. Although the middle school curriculum does not stress "the limits of atom models", "shape of atoms", and "living of atoms", the findings of our interview and science education literature indicate that students hold alternative conceptions of the foregoing (Griffiths, & Preston, 1992; Harrison, & Treagust, 1996). Next, we describe the development and implementation of Armstrong's version of a MI lesson plan.

Theory of Multiple Intelligences

A framework for looking at various ways that learning occurs has been described by Howard Gardner (1983, 1985, 1993) in his theory of multiple intelligences. Gardner examined studies that pertain to individual growth and developmental patterns in a culturally valued activity, borrowing from the works of Jean Piaget (logical-mathematical intelligence), Erik Erikson (development of personal intelligences), and Lev Vygotsky (developmental models of linguistic intelligence). Gardner traced their historical evolution to understand spatial intelligence (from cave drawings to present-day computer and television technologies) and musical intelligence (from evidence of early musical instruments to present-day electronic instruments). Although Gardner does not favor decontextualized standardized test, he analyzed these to identify the seven intelligences. Thus, his theory of multiple intelligence is supported by psychometric findings. Gardner (1983) arrived at the first seven intelligences by studying the capabilities of individuals with brain damage, savants, and prodigies s well as exceptional individuals. Recently, Gardner added an eighth intelligence, naturalist intelligence, sensitivity to aspects of the natural world and the ability to recognize patterns in nature. Gardner conceptualized human potential broadly and initially mapped out the variety of human abilities into eight intelligences: verbal-linguistic, logical-mathematical, spatial-visual, bodily-kinesthetic, musical-rhythmic, interpersonal, intrapersonal, and naturalist.

Multiple intelligence theory is a cognitive model that seeks to describe how individuals use their intelligences to solve problems and fashion products (Armstrong, 1994). Gardner claims that (a) each person possesses all intelligences. Of course, some individuals have well-developed verbal-linguistic intelligence and others have spatial-visual intelligence, (b) everyone has the capacity to develop all intelligences to a reasonably high level of performance if given the appropriate encouragement, enrichment, and instruction, (c) intelligences usually work together in complex ways and are always interacting with each other, (d) there is no standard set of attributes that one must have to be considered intelligent in a specific area. But there are core operations that underlie a specific intelligence. For example, some individuals exhibit sensitivity to pitch and rhythm, thus displaying musical intelligence. Probably, a person may not be able to read, yet be highly linguistic because she can tell a terrific story or has a large oral vocabulary, and (e) the symbols underlie intelligences. For example the language of science is a system of symbols (linguistic intelligence) (Armstrong, 1994). Likewise, design and technology use graphics (spatial intelligence). Since his book of “Frames of Mind The Theory of Multiple Intelligences” many educators have become interested in the theory and many schools, articles, and books have been organized around the theory. This study illustrates how the lesson plans based on MI theory, involving the unit of atom and atomic properties, were developed and implemented in middle school science. The study also repots the effects of student-centered activities based on multiple intelligences theory on grade-7 students' attitudes toward and perceptions of science compared to traditional teaching.

Validity of MI Lesson Plans

All the lesson plans were endorsed by the reviewers mentioned above before the implementation phase. The final lesson plans incorporated the necessary revisions. For example, science teachers and chemistry professors expressed that some of the knowledge structures (relationships among the atoms and chemical bonds) are complex because of the student' ages and the abstract nature of the subject matter. So based on these comments some knowledge structures were dropped. Also experts gave feedback related to scheduling of activities with respect to moving from simple to complex concepts for each lesson.

MI experts solved these dilemmas in our study. They also suggested that students must actively engage in verbal-linguistic activities as opposed to approaching from traditional perspectives.

Incorporating of Students' Preconceptions in Armstrong's Seven-Step Model

There was an important difference between our lesson plans and Armstrong's seven-step model in developing for creating lesson plans based on MI Theory. That is, Armstrong's procedure does not stress the importance of incorporating students' prior conceptions and their reasons or sources related to a specific topic. Our lesson plans identified students' formally or informally held intuitive conceptions, partial understanding and the reasons or sources of their conceptions of atom. For example, as part of our multiple intelligences activities, we designed a bodily-kinesthetic activity for teaching the structure of atom consisting of protons, neutrons and electrons in the first lesson. But, we did not simply cast their roles. In other words, in the beginning of this bodily-kinesthetic activity, we did not directly tell students what they needed to do according to their role during this activity. Instead, we gave all the students (n=18) labeled collar cards: 'proton- (positive)' to 6 students, 'neutron- (neutral)' to 6 students and 'electron- (negative)' to 6 students, but we did not give them their roles related to where they exist and their motions or positions in the structure of an atom. So, firstly three different students represented proton, neutron, and electron in order to represent the structure of atom based on their prior knowledge. Then, three other students representing a proton, a neutron and an electron joined the activity at a specific stage to respectively represent helium, lithium, beryllium, boron and carbon. Also, we encouraged the remaining students to interpret the role-play of their peers.

During this activity, our students displayed several preconceptions about the structure of an atom: 25% of 12 students representing the proton and neutron moved like the electrons move in an orbit. 42% of 12 students representing proton and neutron separated into two groups rather than being close to each other to demonstrate the nucleus of atom. 33% of 6 students who had the collar cards labeled ‘electron- (negative)’ did not move. The rest of students representing the electron moved in a well-defined circular orbit rather than a cloud-like movement.

These conceptions, naturally, led to a discussion about the atomic structure. For example, the students, who were observing the activity and some students representing the proton and neutron asked their peers having the same collar cards to generate only one group for the protons and neutrons existing in a nucleus rather than two separate groups, to represent a nucleus in the center of atom. Also some students asked their classmates representing the electrons to move another orbit, not the same orbit. Because of the discussions that resulted from the bodily-kinesthetic activity, interpersonal and logical-mathematical intelligences were observed. For example, students participated in a dialogue with respect to the position and motion of the sub-particles in the atomic structure.

We believe that the students’ idea that “model is reality” restricts their modeling ability or constructing mental images of the atom. So, we had allocated one lesson for the limits of the atomic models. When students became aware of their own conceptions, we did the same bodily-kinesthetic activity by assigning them to correct roles to depict structure of an atom. Each of the subsequent lessons was designed with separate and different three or four major multiple intelligences activities. However, like the above activity, each student-centered activity led students to involve in two or more other multiple intelligences.

Instrument

Development of the questionnaire was based upon the review of pertinent literature (Chiappetta, Waxman, & Sethna, 1990; Hofstein, Ben-Zvi, and Samuel, 1976; Simpson, Koballa, Oliver, & Crawley, 1994; Shepardson & Pizzini, 1993, 1994), negotiation with middle school science teachers and students, and finally the incorporation of lessons learned from a pilot study. The Questionnaire of Attitudes toward and Perceptions of Science (QAPS) consisted of 19 item-Likert Scale. The questionnaire items consisting of positive and negative items were administrated to the students on 'strongly agree', 'agree', 'undecided', 'disagree' and 'strongly disagree' scale (scored 5, 4, 3, 2 and 1 respectively for positive items, reverse scoring for negatively stated items). The original 25-item of QAPS was reduced to 19 items after a pilot study in the previous academic year. Three science teachers and two university science educators also examined each item of the questionnaire with respect to content validity. The final questionnaire was designed to be concise and straightforward to reduce resistance or rejection from students. QAPS consisted of two factors: Twelve items loaded on the first factor, attitude toward science (ATS). Specially, two domains of attitude toward science were measured: specific interest and science in the school curriculum (see Appendix A). Another seven items loaded on the second factor, which appeared to measure two domains of perceptions of science (POS): the nature of science, and the importance of science to society (see Appendix B). The reliability coefficients for the ATS and POS were respectively 0.72 and 0.75.

Data Analysis

A one-way between groups multivariate analysis of covariance (MANCOVA) was used to analyze whether or not there are significant differences between the control group and the experimental group on the cumulative (total) scores of posttest of Questionnaire of Attitudes toward and perceptions of Science (QAPS). In this study, two dependent variables were used “attitudes toward science” and “perceptions of science” The independent variable was the type of treatment (traditional teaching and multiple intelligences theory). In the beginning of the study, students’ scores on the pre-intervention administration of both ATS and POS were used as the covariates. The assumptions of MANCOVA and correlations among the covariates were checked. Moreover, chi-square item analysis was conducted for each item of ATS and POS in both pretests and posttests.

Results

The results of MANCOVA on the students’ posttest scores of the ATS and POS with pretest scores of these as the covariates firstly indicated that there was a significant difference between the control and experimental groups on the combined dependent variables: $F(2, 45) = 10.09$, $p < .001$; Wilks’ Lambda = .69; partial eta squared = .31. 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 divide by the number of ANCOVAs conducted) as follow-up tests to the MANCOVA. Table 1 summarizes the means and standard deviations of pretests of ATS and POS used as the covariates in this study.

Insert Table 1

Table 1 shows that the means of students' prescores on the ATS and POS for both groups are nearly the same. Also, the values in this table indicate that students in both groups had positive attitudes toward and perceptions of science in the beginning of the study because the maximum values of ATS, consisting of 12 items, and of POS, consisting of 7 items, are respectively 60.00 and 35.00. When separately compared these maximum values with the means values of the same questionnaire for each group, it may be said in the beginning of the study that students in both groups have 75% for ATS as a percentage (45.20 or 44.36 / 60.00) x 100), and 77% for POS as a percentage.

Students' Attitudes toward Science

Table 2 summarizes the results of ANCOVA on the posttest scores of ATS. The tabulated data indicated that there were significant differences, $F = (1, 46) = 15.43$, $p < .001$, between the experimental and control groups.

Insert Table 2

The adjusted mean posttest scores of the ATS in Table 3 indicate that the control group had an adjusted mean of 44.62 on the ATS posttest, while experimental group had an adjusted mean of 52.29 on the ATS posttest. These results show that students taught with student-centered activities of MI theory significantly developed more positive attitudes toward science than those in the control group learning based on traditional teaching.

Insert Table 3

When we separately compared the means of students' pre- and post-scores through Tables 1 and 3 for the same group without comparing the two groups for the ATS, the means of control group students' pre- and post-scores are respectively 45.20 and 44.72. According to these values that are nearly the same, it may be said traditional teaching does not positively or negatively affect students' attitudes toward science. The means of the experimental group students' pre- and post-scores are respectively 44.36 and 52.20. This increase in scores indicates that the student-centered activities based on multiple intelligences theory positively affected students' attitudes toward science.

Students' Perceptions of science

The results of ANCOVA on the posttest scores of POS are shown in Table 4. Statistical analysis indicated that there were significant differences, $F = (1, 46) = 14.25$, $p < .001$, between two groups.

Insert Table 4

The adjusted mean posttest scores of the POS in Table 5 show that the control group had an adjusted mean of 26.33 on the POS posttest, while experimental group had an adjusted mean of 30.25 on the POS posttest. This result indicates that students learning with student-centered activities based on MI theory significantly developed more positive perceptions of science than those in the control group who learned using traditional method.

Insert Table 5

When we separately compared the means of students' pre- and post-scores through Tables 1 and 5 without comparing the two groups for POS, the means of control group students' pre- and post-scores are respectively 26.88 and 26.12. According to these values that are nearly the same, it may be said traditional teaching does not positively or negatively affect students' perceptions of science. The means of the experimental group students' pre- and post-scores are respectively 27.40 and 30.36. This increase inn scores indicates that the student-centered activities based on multiple intelligences theory positively affected students' perceptions of science.

Moreover, a chi-square item analysis was conducted for each item of both ATS and POS. In this analysis, however, the categories of 'strongly agree' and 'agree' were combined to provide one response as 'agree' and the categories of 'strongly disagree' and 'disagree' were combined to provide one response as 'disagree'. As a result of this process, five response categories were transformed into three response categories as 'agree', 'undecided', and 'disagree' for the individual chi-square comparisons. This analysis was conducted on both pretests and posttests. In the beginning of the study, we found out that there was no significant difference in any item between groups on the pretests; while at the end of study we observed that there were significant differences ($p < .05$) favoring students in the experimental group in 5 items. They are items 7 and 12 relating to the students' attitudes toward science, and items 2, 4, and 5 concerning the students' perceptions of science. The chi-square item analysis related to the students' attitudes toward science is given in Table 6.

Insert Table 6

Table 6 shows that for item 7, a positive statement, "*I want more time to be allocated for science course,*" 24% of the students in control group agreed, 44% of them undecided, and 32% of them disagreed, whereas these percentage values in the experimental group were respectively 72% for agree, 24% for undecided, and 04% for disagree. When these percentages are compared with each other, it is shown that 24% of the control group students agreed. While this percentage for the experimental group students is 72% for the same category. In Table 6, for the item 12 in the ATS, a negative statement, "*I think that science course is a waste of time,*" 16% of the students in control group agreed, 12% of them undecided, and 72% of them disagreed, whereas all students in the experimental group disagreed. Comparing the percentages shows that 7 out of 25 students in the control group agreed and undecided, while none of the experimental group students preferred these categories.

We think that these items are very important for understanding the effects of the implementation of MI theory on students' attitudes toward science courses in the school curriculum. Because the nature of these items supporting each other indicate that there was a significant difference favoring the experimental group with respect to students' desire for more science courses in the school curriculum.

Insert Table 7

The chi-square item analysis related to the students' perceptions of science is given in Table 7. The three items exhibiting significant differences favored the experimental group according to the chi-square item analysis are 2, 4, and 5 related to students' perceptions of science. For item 2, a positive statement, "*Science has an important place in everyday life*,"
64% of the students in control group agreed, 28% of them undecided, and 08% of them disagreed, whereas these percentage values in the experimental group were 92% for agree,

04% for undecided, and 04% for disagree. According to the values in Table 7, it is shown that 9 of the control group students undecided and agree, while only 2 of the experimental group students prefered the same choices. We think that the results of item 2 is a very important piece of evidence for revealing students' perceptions about the relationship between everyday life and science or the importance of science to society.

For item 4, a negative statement, "*There is no need for science to explain natural phenomena,*" 24% of the students in control group agreed, 16% of them undecided, and 60% of them disagreed, whereas nobody in the experimental group preferred the category of agree, 12% of them undecided, and 88% of them disagreed. Comparing the values in Table 7 for this item shows that 10 out of 25 students in the control group preferred the choices of undecided and agreed, but only 3 students in the experimental group were undecided for this item. Also, for item 5, a positive statement, "*Science improves my research character and curiosity,*" 60% of the students in control group agreed, 16% of them undecided, and 24% of them disagreed, whereas nobody in the experimental group preferred the category of disagree, 04% of them undecided, and 96% of them agreed. When these percentages are compared with each other, it is shown that 40% of the control group students diasgreed and undecided, while 04% of the experimental group students were undecided.

We think that these items are very important for understanding the effects of the implementation of MI theory on students' perceptions of science. These items supporting each other indicate that there was a significant difference favoring the experimental group with respect to students' perceptions about the nature of science.

Discussions

The purpose of this study was to investigate whether or not student-centered activities based on MI theory would significantly improve grade-7 students' attitudes toward and perceptions of science compared to traditional teaching. The data in this study confirm a significant improvement favoring the MI theory. We have not yet encountered a research study, which investigated the effects of the implementation of the MI theory on students' attitudes toward and perceptions of science. But, the findings of this study support the results of previous studies, which investigated the effects of instructional strategies or activities on students' attitudes toward and perceptions of science (Chiappetta, Waxman, & Sethna, 1990; Shepardson, & Pizzini, 1993, 1994). However, Goodnough (2001) in a case study reported that 85% of 13 ninth-grade students expressed that MI theory helped the students enjoy science more, involving the unit of space and astronomy. Also, Daniel (1997) using the activities based on MI theory to teach his students a unit on periodic table suggests that if science teachers can provide many different learning styles, they have given every student an opportunity to learn and enjoy science.

According to Chiappetta, Waxman, and Sethna (1990), it is difficult to change students' attitudes toward and perceptions of science, due to the complex nature of human learning. Also, it is easier to improve students' achievement than their attitudes toward and perceptions of science. In addition to this very difficult change, in the beginning of this study, we were aware that the atom and atomic properties was not an appropriate topic with respect to improving students' attitudes toward and perceptions of science. The study of atom and atomic properties is one of the most difficult topics among all science (chemistry) topics because of its abstract nature, especially to the middle school science students. For example, the units of space and astronomy or animals and plants are more concrete than the atom and atomic properties. This situation is problematic for statistical comparisons. Our second doubt prior to the study was that lessons based on multiple intelligences theory would take more time compared to traditional teaching. Moreover, the experimental group did not have experience in learning science using the multiple intelligences prior to the treatment. Despite these disadvantages, this study showed that even if the selected topic is very abstract and students do not have experience on MI activities, students-centered activities based on MI theory improve students' attitudes toward and perceptions of science. We also found out that the time was not an issue in the context of the MI theory lessons because students readily understood and adapted the student-centered activities of MI theory after the first lesson. In this connection, we think that the introduction to MI theory before the treatment facilitated and accelerated the process of students' adaptation.

Besides the results of the cumulative scores of ATS and POS that indicated significant differences favoring the experimental group, especially the chi-square analysis presented the detailed information that there were significant difference significant differences ($p < .05$) favoring students in the experimental group based on 5 items on the posttests after the treatment. Items 7 and 12 of the five items show the positive effects of srtudent-centered activities based on MI theory on students' attitudes concerning the science courses in the school curriculum. Similarly, items 2, 4 and 5 are important pieces of evidence of the positive effects of srtudent-centered activities based on MI theory on the students' perceptions about the nature of science and the importance of science to society.

We used Armstrong's seven-step model for creating the MI lesson plan. But there is an important difference in development and implementation of our lesson plans compared to

Armstrong’s seven-step model. This difference is the identifying students’ preconceptions and the reasons. We designed all activities to reveal students’ preconceptions and the reasons. The new step also includes students’ awareness concerning their own conceptions and reasons, not only their teacher’s awareness. Teachers generally use classical instruments such as open-ended and multiple choice questions for identifying students’ preconceptions and the reasons. However, these instruments generally do not represent detailed information related to especially the sources of students’ preconceptions, and are not effective for providing students’ awareness on their own conceptions and the sources. The students and we naturally had detailed information related to their preconceptions, the reasons, and students’ awareness by means of the activities of MI theory. Because of these reasons, we think that MI activities should be taught in a manner that is able to identify students’ preconceptions, the reasons, and students’ awareness. Also, incorporating stuudents’ conceptions provided opportunitis to create student-centered activities. These lessons also activated students’ other intelligences, while one intelligence was dealt with.

Gardner (1997) states, “MI is not a quick fix. But educators who thoughtfully use the theory to support their larger educational goals find that it is a worthy partner in creating schools of excellence” (p. 20). During this study, we found out that the nature of MI theory presented us with many different ways of teaching the same knowledge structures of atomic properties. Different styles of teaching science gave opportunities for students to engage in their own learning. In our study, we found that students who learn by using their multiple intelligences felt more competent and confident and enjoyed the challenge of constructing new ideas of atom and atomic properties. Also, students who understood their weaknesses struggled to promote their intelligences. We attribute their positive feelings toward science to the student-centered activities based on MI intelligences. As well, we think that the individual portfolio approach to monitor students’ learning had an important contribution to students’ attitudes toward and perceptions of science and also empowered them to become responsible for their own learning. For example, some samples included in students’ individual portfolios are seen in the Appendices. Often, students talked about the development of their intelligences in their protfolios. We also observed that the sharing of individual portfolios developed better relationships between teacher and student and among peers. In the light of all our findings, we conclude that student-centered activities based on multiple intelligences significantly improve grade-7 students’ attitudes toward and perceptions of science compared to traditional teaching.

Implications

Traditionally, education has been directed at verbal-linguistic and logical-mathematical intelligences as teacher-centered (Emig, 1997; Goodnough, 2001). The present study implies that these intelligences can be developed through student-centered activities. As well, the learning involves all intelligences of MI theory. In this connection, science teachers should make an effort to see that all students learn even the abstract topics such the atom and atomic properties through concrete activities that involve multiple intelligences. Perhaps, what is even more important, is that students enjoy learning science because middle school years are an important period to affect students' attitudes and perceptions more positively toward science and in their further science learning.

Vialle (1997) states, "The most significant change I have noted is a shift from teaching and learning as a teacher-centered activity to teaching and learning as a student-centered activity" (p. 66). Our student-centered activities based on MI theory contributed to the development of students' attitudes toward and perceptions of science. The more students become engaged actively in their own science learning, the more they would develop positive attitudes toward and perceptions of science.

Ebenezer and Haggerty (1999) expressed that MI theory provide a framework on which to structure lesson plans and also help teachers view students as individuals who learn in different ways. The findings of this study indicate that when teachers give students the opportunities to use their stronger intelligences and to recognize their weak intelligences, they become much more engaged in their learning. We have also identified that when we teach science topics according to multiple intelligences theory, teachers recognize that they have a responsibility to develop each student's capabilities in each intelligence. The practice of MI theory also contributes to the development of better relationship between teacher and student as well as among students. Finally, what is more important than the results of the statistical analysis in this study was that 90% of students in the experimental group wanted to continue their sequential science lessons without a break. This kind of behavior especially in the middle years is an important piece of evidence indicating the positive effects of the implementation of MI theory on students' attitudes toward and perceptions of science.

Appendix-A.

Questionnaire of Attitudes toward Science

1	Science is interesting and exciting.
2	I want to learn more about science.
3	Science is boring.*
4	I enjoy reading about science.
5	Science is too complex and difficult to understand.*
6	I like solving problems related to science.
7	I want more time to be allocated for science course.
8	I think that science course in school is unnecessary.*
9	I like science course in school.
10	I allocate a big part of my study time to science course.
11	Science is the most boring of all the courses in school.*
12	I think that science course is a waste of time.*

* Items are reverse scored

Appendix-B.

Questionnaire of Perceptions of science

1	Science leads me to think and investigate.
2	Science has an important place in everyday life.
3	Logical and critical thinking in science is very important.
4	There is no need for science to explain natural phenomena.*
5	Science improves my research character and curiosity.
6	There is very little thinking involved to understand science. *
7	Science helps me to better understand natural phenomena.

* Items are reverse scored.

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Table 1. Means and Standard Deviations of the Experimental and Control Groups for Pretests of the ATS and POS as used the covariates.

Test	Control Group (N = 25)	Experimental Group (N = 25)
ATS (pretest)	45.20 5.96	44.36 8.42
POS (pretest)	26.88 4.25	27.40 4.30

Table 2. The results of ANCOVA for posttest scores of ATS

Source of Variation	Sum of Squares	df	Mean Square	F	p
Covariates					
ATS (pretest)	491.09	1	491.09	10.40	.002
POS (pretest)	108.97	1	108.97	2.31	.136
Treatment	728.44	1	728.44	15.43	.000
Residual (Error)	2172.41	46	47.23		
Total	3620.42	49			

Table 3. Unadjusted mean scores, standard deviations, adjusted mean scores and standard errors of adjusted mean of the ATS posttest for two groups.

Groups	N	Unadjusted mean	SD	Adjusted mean
Control Group	25	44.72	9.20	44.62
Experimental Group	25	52.20	6.08	52.29

Table 4. The results of ANCOVA for posttest scores of POS

Source of Variation	Sum of Squares	df	Mean Square	F	P
Covariates					
ATS (pretest)	7.47	1	7.47	.531	.470
POS (pretest)	215.88	1	215.88	15.36	.000
Treatment	200.23	1	200.23	14.25	.000
Residual (Error)	646.41	46	14.05		
Total	1127.12	49			

Table 5. Unadjusted mean scores, standard deviations, adjusted mean scores and standard errors of adjusted means of the POS posttest for two groups.

Groups	N	Unadjusted mean	SD	Adjusted mean
Control Group	24	26.12	5.26	26.23
Experimental Group	20	30.36	3.15	30.25

Table 6. Chi Square comparisons, frequencies, percentages for the items 7 and 12 in the ATS

Item	Group	*Categories*			Total	df	X^2	p
		Agree	Undecided	Disagree				
7. I want more time to be allocated for science course.	CG	6 (24%)	11 (44%)	8 (32%)	25 (100%)	2	12.91	.002
	EG	18 (72%)	6 (24%)	1 (4%)	25 (100%)			
12. I think that science course is a waste of time.	CG	4 (16%)	3 (12%)	18 (72%)	25 (100%)	2	8.140	.017
	EG	0 (0%)	0 (0%)	25 (100%)	25 (100%)			

CG = Control Group
EG = Experimental Group

Table 7. Chi Square Comparisons, frequencies, percentages for the items 2, 4, and 5 in the POS

Item	Group	*Categories*			Total	df	X^2	p
		Agree	Undecided	Disagree				
2. Science has an important place in everyday life.	CG	16 (64%)	7 (28%)	2 (8%)	25 (100%)	2	6.09	.048
	EG	23 (92%)	1 (4%)	1 (4%)	25 (100%)			
4. There is no need for science to explain natural phenomena	CG	6 (24%)	4 (16%)	15 (60%)	25 (100%)	2	7.47	.024
	EG	0 (0%)	3 (12%)	22 (88%)	25 (100%)			
5. Science improves my research character and curiosity.	CG	15 (60%)	4 (16%)	6 (24%)	25 (100%)	2	9.88	.007
	EG	24 (96%)	1 (4%)	0 (0%)	25 (100%)			

CG = Control Group
EG = Experimental Group