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# EFFECTS OF HANDS-ON ACTIVITY ENRICHED INSTRUCTION ON STUDENTS' ACHIEVEMENT AND ATTITUDES TOWARDS SCIENCE

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**Abstract.** *This study aimed to investigate the effectiveness of hands-on activity enriched instruction on sixth grade students' achievement and attitudes toward science. In this study, Science Achievement Test and Science Attitude Scale were used to assess students' achievement on sense organs and students' attitudes toward science respectively. Two teachers with four classes and total of 140 sixth grade students were participated in this study. One class of each teacher was assigned as experimental group and treated with hands-on activity enriched instruction and other class was assigned as control group and treated with traditional instruction. The Science Achievement Test and the Science Attitude Scale were administered twice as pre-test and after three week treatment period as a post-test to both experimental and control groups to measure students' achievement and attitudes. Multivariate Analyses of Covariance (MANCOVA) results revealed that hands-on activity enriched instruction were more effective than traditional instruction. However, the statistical results failed to show a significant difference between the experimental and control groups' attitudes toward science.*

**Key words:** *attitudes toward science, hands-on activities, science achievement, sense organs.*

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## Introduction

Over the years there has been a continuing reform effort for improvement in the quality of science education in different countries. It is suggested that quality science instruction requires the active participation of learner. In 1980, Dewey highlighted the proposals about activity-based learning and child-centered instruction and after that science curriculum studies has been emphasizing and giving importance to science learning with hands-on activities (Hodson, 1990). Recently, educational researchers have been showing the factors affecting students' achievement and attitudes toward science and they have been conducting many studies to improve students' science achievement (Randler & Hulde, 2007; Taraban, Box, Myers, Pollard & Bowen, 2007; McCarthy, 2005; Hofstein & Lunetta, 2004; Bristow, 2000; Salend, 1998) and also attitudes (Ornstein, 2006; Osborne, 2003; Hofstein, Mooz & Rishpon, 1990) by using hands-on and inquiry based programs. For example, the study of Randler and Hulde (2007) was related with the effect of hands-on programme on student's achievement about soil ecology. A total of 123 fifth and sixth grade students contributed in the study. Result indicated that students in the hands-on group demonstrated higher achievement than student in traditional textbook based programs. Similarly, Taraban et al. (2007) studied with 408 students from six high schools to investigate the effect of a hands-on inquiry laboratory programme on students' biology achievement. The results revealed that use of hands-on inquiry laboratory gave an advantage to students to become more active learner, to enhance content knowledge and to develop science process skills.

Various interpretations of what is meant by "hands-on learning" has been proposed so far and the most common and accepted definition was that hands-on learning is learning by

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doing. It involves enabling the child's ability to think critically in a total learning experience. On the contrary to traditional beliefs, learning by hands-on activities does not mean just managing or modifying the materials, but involving profundity of investigation using ideas, objects and materials as well as drawing the depth of investigations with objects, materials and phenomena. It entails using ideas and implicating the meaning and understanding from the experiences that students perform (Haury & Rillero, 1994).

Hands-on science has also been defined as any science laboratory activity which allows the students to handle, observe and manipulate a scientific process (Lumpe & Oliver, 1991). It can be differentiated from conventional lectures and demonstrations in that, students interact with materials to make observations and it involves many activities. Furthermore, laboratory or class experiments differ from hands on activities in two aspects. Firstly, especially in primary and secondary school, students cannot do laboratory but perform hands-on science activities in their regular classroom, and secondly, students can carry out hands-on activities that are not actual experiments as observations or measurements (Ruby, 2001). Besides, hands-on activities do not need some special materials and learning context.

Hands-on science is important to enhance learners' success because students actively involve the learning process by manipulating objects or materials to gain knowledge; so that they can construct their own understanding of scientific concepts. By working with materials or objects, students become more motivated and excited to join the lesson. It enables them to become critical thinkers, active learner, and researcher.  Hands-on activities also enhance students' interest and curiosity to follow and understand environmental problems or scientific phenomena in real life (Poude, Vincent, Anzalone, Huner, Wollard, Clement, DeRamus & Blakewood, 2005).

Additionally, the results from the Programme for International Student Assessment (PISA) revealed that in Turkey, students' science achievement significantly lower than the average of OECD countries (OECD, 2004, 2010). So, recent educational reform efforts in Turkey are intended to overcome this problem and to increase the quality of an education system. One of main objectives of this educational reform is to move from a teacher-centered didactic model to a student-centered constructivist model (Akşit, 2007). Considering the fact that fundamental reforms in the new teaching strategies advocate and support the hands-on learning in science, the present study examined the effectiveness of hands-on activity enriched instruction on the sixth grade students' science achievement attitudes toward science. There have been many studies about hands-on learning focusing on different biology topics as earth and space science concepts, prokaryotic and eukaryotic cells, DNA structure and function, protein synthesis, and natural selection, biotechnology, cellulose enzyme, water, and gene technology (e.g. Scharfenberg & Bogner, 2010; Randler & Hulde, 2007; Paris, Yambor & Packard, 1998). However, effect of hands-on instruction related with the topic of sense organ has not been investigated in biology education. This topic is an important part of science curriculum in Turkey. Moreover, concepts related to sense organs are important for learning of another concept of nervous system. For these reasons sense organs were chosen as a topic in this study.

The results of this study provide some valuable feedback to science teachers and science educators in Turkish educational system for several reasons. Although relevant studies have recommended science instruction based on inquiry, rather than textbook implementation, by allowing the students to carry out scientific research on their own understanding (Gerstner & Bogner, 2010), student-centered experiments and hands-on activities are still rare in regular classroom instruction (Bohl, 2001). Similarly, in Turkey, today's science instruction in the classroom depends on mostly reading or listening of scientific facts and taking notes and memorizing. Therefore, this study gives information about the hands-on instruction which ensure the idea that away from memorization. Secondly, science teachers and researchers can get benefits about how to implement hands-on activities enriched instruction in science, and how hands-on activities affect students' science achievement and attitude toward science in the topic of sense organs. By this way teachers will have an opportunity to use of hands-on activities with simple and low-cost daily life materials in their classrooms to attract students' attention and to make science lesson fun. Besides, students can make connections between science concepts when they carry out different hands-on activities for different subjects of the science. Finally, this study can assist curriculum developers when they evaluate their science programs to increase student science achievement.

In this study, the aim is to investigate the effects of hands-on activity enriched instruction on sixth grade students' science achievement and attitudes toward science. This study compared the effectiveness of the hands-on activity enriched instruction related to sense organs with traditionally designed science instruction on sixth grade students' achievement and attitudes toward science.

*Purpose of the Study*

In the light of the findings in the literature, this study aimed to find out answers to the following questions:

1. What are the effects of hands-on activity enriched instruction and traditional instruction on $6^{th}$ grade students' science achievement when students' previous science course grades and previous cumulative grade point average are controlled?
2. What are the effects of hands-on activity enriched instruction and traditional instruction on $6^{th}$ grade students' attitude toward science when students' previous science course grade, previous cumulative grade point average and science attitude pretest scores are controlled?

## Methodology of Research

Experimental research as a research methodology was used in this study since it is the best way to establish cause and affect relationships between variables. At the beginning of the study, the teachers were trained by the researchers. A teacher handout including necessary information about hands-on activities was prepared. By this way, teachers could know how to teach sense organs in both experimental group and control group. Moreover, the teachers allowed researchers to observe their classes.

*Instruments*

Three measuring tools were used in this study named as the Science Achievement Test (SAT), the Science Attitude Scale (SAS) and observation checklist.

*Science Achievement Test (SAT)*

The SAT developed by the researchers was used to assess students' achievement about sense organs. It covers the science content present in the sixth grade science curriculum. It consists of 25 multiple choice questions related with all of five sense organs; eye, ear, nose, tongue and skin. Possible SAT scores range from 0 to 25, with higher scores showing greater achievement in sense organs topic.

The SAT was administered as a pretest and posttest to both control and experimental groups to assess students' science achievement about sense organs. The researchers preferred to use multiple choice questions as a test questions due to ease of application and objectivity. Reliability of science achievement test was found to be 0.68.

*Science Attitude Scale (SAS)*

The SAS developed by Geban, Ertepınar, Yılmaz, Atlan and Sahpaz (1994) was used to assess students' attitudes toward science. This scale consists of 15 items and designed to be rated on a 5-point Likert type response format (strongly disagree, disagree, neutral, agree, and strongly agree). SAS was administered as a pretest and posttest to both control and experimental groups. Possible SAS scores range from 24 to 120, with higher scores demonstrating positive attitude toward science and lower scores demonstrating negative attitudes toward science. For present study, reliability of SAS was found to be 0.82.

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*Observation Checklist*

During the treatment, both the control and the experimental groups were observed to identify whether the teachers follow the treatment rules. The observer used the checklist consisted of 12 items, two of which were negative form for the hands-on activity criteria. First 10 items rated on five-point response format that indicate how frequently some actions were done in the classroom. In addition, one item indicates whether the activities were done alone, in pairs or in groups of three and other item shows how much time the students spend on doing hands-on activities, were designed to be rated on four-point response format. Each item conclude with "no activity" option to check whether the control group done any activity or not. Two researchers observed both experimental and control group classes during the study and filled the observation checklist for both groups.

*Treatment*

Experimental research as a research methodology was favored since it is the best way to establish cause and affect relationships between variables. A quasi-experimental study design was preferred as an experimental model in view of the fact that it does not include random assignment.

Both hands-on activity enriched instruction and traditional instruction lasted about three weeks of second semester of school. The science course consisted of three 40-min lessons per week. At the beginning of the study, the teachers were trained by the researchers and they were given a handout indicating what they should do during the hands-on activities. By this way, teachers could know how to teach sense organs in both experimental group and control group.

Two measuring tools were used in this study. The one; SAT, was used to assess students' achievement about sense organs and the other; SAS, was used to assess students' attitudes toward science. SAT and SAS were applied to both groups as a pretest one week before the treatment. In addition, some background information was collected from the students such as their age, gender, mother education, and father education. Test application took approximately one class hour for pre-test and post-test separately.

The students in the control groups and the experimental groups treated with different methods of teaching. In control group, traditional method was used. That is; teacher-centered instruction was applied and students were generally taught with note-taking strategy. The teacher gave some important concepts about sense organs and the students wrote the teachers' explanations in their notebook. The teacher did not use any demonstrations or activities. On the other hand, in experimental group, hands-on activity enriched instruction was employed. In this type of instruction, student-centered instruction was applied and students got the information by doing hands-on activities individually or in groups. These activities were not only hands-on but also minds-on keeping students as active problem solvers and decision makers. Activity sheets helped them to perform the eye, ear, nose, tongue and skin activities (Table 1). Students followed the procedures of the activity and then answered the questions about this activity using handouts about the subject. However, these activities did not tend to be much directed, "cookbook" in nature.

During the treatment, teachers act as a guide for students' learning in the experimental groups. After that, all students discussed each questions of activity in the classroom before performing the next one. Finally, the teachers explained some important scientific terminology related to the activity and the subjects. They also gave information about critical points of sense organs at the end of each activity. For example, in the topic of eye, students tried to answer questions of "how the light affects our eyes?", "Why do we have two eyes?", "How do we understand the different colors?", "What is color blindness?", "What is the meaning of blind spot?" Students completed hands-on activities that help them use pre-existing knowledge to explore new concepts or explore questions and design/conduct a preliminary investigation. Therefore, students performed hands-on activities by group work which fosters a deeper and more active learning process in all activities. In addition to exposing students to different approaches and ways of thinking, working with other students in groups also gives them the opportunity to learn from each other. Thus, this group work provides an opportunity to obtain conceptual understanding.

**Table 1. Hands-on activities about sense organs.**

| Topic | Name of activities |
|---|---|
| Eye | 1. The structure of the eye |
| | 2. The effects of the light |
| | 3. Why do we have two eyes? |
| | 4. How do we understand the different colors? |
| | 5. Color blindness |
| | 6. Finding of blind spot |
| Ear | 1. What is vibration? |
| | 2. Vibration in the ear dice |
| Nose | 1. Different smells |
| | 2. Spread of the smells |
| Tongue | 1. Sweet, salty and bitter |
| | 2. Smell and taste |
| Skin | 1. Heat or cold? |
| | 2. Do we feel materials same in all part of skin? |

Observation checklist was used for both groups during the study to confirm proper treatment implementation. The checklist showed the degree to which the course was taught with hands-on activities. Finally, SAT and SAS were applied as a posttest after three weeks treatment for control and experimental groups. Test scoring was done and computed.

*Participants*

The sample of the study consisted of 140 (71 girls, 69 boys) 6th-grade students who were 12 year of age attending four whole classes in one public elementary schools in Ankara, Turkey. The present study involved a total of two experimental groups (*n* =72; 31 boys, 41 girls) and two control groups (*n* = 68; 38 boys, 30 girls). Student's socio-economic status and their family income can be assumed as near to each other.

In Turkish elementary schools, science lessons are compulsory for all students. Duration of science lessons is four 40-min periods per week, and teachers generally use traditional instruction to teach science concepts. Textbooks are the main source of science instruction. The teaching strategies, thus, generally rely on teacher explanation and extensive use of textbooks.

There were 72 students in experimental group which was taught with hands-on activity enriched instruction and 68 students in control group taught by traditional instruction.

**Results of Research**

Table 2 shows descriptive statistics for the science achievement scores and science attitude scores. As presented in the Table 2, experimental group showed mean increase ranging from 6.64 to 15.25 in their level of science achievement from the pretest to posttest. However, the control group showed a mean increase ranging from 7.32 to 11.57 in their level of science achievement from the pretest to posttest. Therefore, experimental group shows a mean increase of 8.61 whereas the change of control group is 4.25 points on the SAT which indicates that the students in the hands-on group performed overwhelmingly better score than the control group students.

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**Table 2. Descriptive statistics for the science achievement scores and science attitude scores.**

| | Experimental Group | | Control Group | |
|---|---|---|---|---|
| Scores on Science Achievement Test | Pretest | Posttest | Pretest | Posttest |
| N | 72 | 72 | 68 | 68 |
| Mean | 6.64 | 15.25 | 7.32 | 11.57 |
| Standard Deviation | 2.53 | 3.39 | 2.57 | 3.87 |
| Skewness | 0.147 | -0.506 | -0.101 | 0.647 |
| Kurtosis | -0.441 | -0.583 | -0.374 | 0.114 |
| Range | 11 | 14 | 11 | 17 |
| Minimum | 1 | 7 | 2 | 5 |
| Maximum | 12 | 21 | 13 | 22 |
| Scores on Science Attitude Test | Pretest | Posttest | Pretest | Posttest |
| N | 72 | 72 | 68 | 68 |
| Mean | 56.57 | 58.69 | 57.94 | 58.80 |
| Standard Deviation | 8.92 | 8.64 | 7.95 | 8.24 |
| Skewness | 0.283 | -0.208 | -0.306 | -0.379 |
| Kurtosis | 1.78 | -0.71 | 0.59 | -0.453 |
| Range | 56 | 36 | 36 | 38 |
| Minimum | 33 | 36 | 39 | 37 |
| Maximum | 89 | 75 | 82 | 85 |

Table 2 also showed the pretest and posttest attitude scores towards science of all students who participated in the study according to experimental and control group. Higher attitude scores mean more positive attitude towards science and lower attitude scores mean negative attitude towards science. Although the experimental groups' scores showed mean increase of about 2.12 points in their science attitude scores from pretest to posttest, the control groups' scores showed mean increase of about 0.86 points from pretest to posttest scores.

Multivariate analysis of covariance (MANCOVA) model was used to test the hypothesis of this study and assumptions of MANCOVA- normality, homogeneity of regression, equality of variances, multicollinearity and independency of observations- were also verified (data not shown).

The variables of the students' previous science course grade (PSG), students' previous cumulative grade point average (GPA) and students' science attitude pre-test scores (PSAS) were pre-determined as potential extraneous factors of the present study. Therefore, these variables were used as covariates to statistically equalize the differences between experimental and control groups. All these pre-determined independent variables have been correlated with the two dependent variables (students' science achievement posttest scores (PSTACH) and science attitude posttest scores (PSTATT)). The results of these correlations are presented in Table 3. As shown in the table, all independent variables have significant correlation with one of the dependent variables.

**Table 3. Significance test of correlations between dependent variables and covariates.**

| Variables | Correlation Coefficient | |
|---|---|---|
| | PSTACH | PSTATT |
| PSG | 0.369* | 0.395 |
| GPA | 0.460* | 0.233 |
| PSAS | 0.138 | 0.572* |

* Correlation is significant at the 0.05 level (2-tailed)

As seen in Table 4, correlations among independent variables are less than 0.8. Therefore, PSG, GPA and PSAS can be used as covariates for the inferential statistics.

**Table 4. Significance test of correlations among the covariates.**

| Variables | PSG | GPA | PSAS |
|---|---|---|---|
| PSG | | 0.60* | 0.384* |
| GPA | | | 0.237* |

* Correlation is significant at least 0.05 level (2-tailed)

Table 5 indicates the results of multivariate analysis of covariance (MANCOVA) which was conducted to determine the effect of methods of teaching on the PSTACH and PSTATT when previous science course grades, previous cumulative grade point average, science attitude pretest scores were controlled. The dependent variables of this study were the posttest scores of the PSTACH and PSTATT. The variables of the PSG, GPA and PSAS were covariates of the study. Table 5 indicates the results of MANCOVA. As seen from the table, methods of teaching (MOT) explain 25.0 % variance of model for the collection dependent variables of the PSTACH and PSTATT.

**Table 5. MANCOVA test results.**

| Effect | Wilks' Lambda | F | Hypothesis df | Error df | Sig. | Eta Squared | Observed Power |
|---|---|---|---|---|---|---|---|
| Intercept | 0.758 | 6.39 | 2.0 | 134 | 0.000 | 0.080 | 0.923 |
| PSG | 0.918 | 5.96 | 2.0 | 134 | 0.003 | 0.082 | 0.873 |
| GPA | 0.960 | 2.781 | 2.0 | 134 | 0.002 | 0.040 | 0.540 |
| PSAS | 0.759 | 21.242 | 2.0 | 134 | 0.000 | 0.241 | 1.000 |
| MOT | 0.750 | 10.336 | 2.0 | 134 | 0.000 | 0.250 | 0.968 |

* $p<0.05$

An analysis of covariance (ANCOVA) was also conducted to determine the effect of independent variables of the methods of teaching on each dependent variable of PSTACH and PSTATT. Result of the statistical analysis of ANCOVA indicates that the students instructed by hands-on activities enriched instruction gained more science achievement about sense organs than the students instructed by traditional method (Table 6).

**Table 6. Test of between subjects effect.**

| Source | DV | TypeIII Sumof Squares | df | Mean Square | F | Sig. | Eta Squared | Observed Power |
|---|---|---|---|---|---|---|---|---|
| MOT | PSTACH | 439.507 | 1 | 439.507 | 23.444 | 0.000 | 0.243 | 1.000 |
| | PSTATT | 51.583 | 1 | 51.583 | 1.133 | 0.289 | 0.008 | 0.600 |
| Error | PSTACH | 1365.733 | 135 | 10.117 | | | | |
| | PSTATT | 6146.079 | 135 | 45.527 | | | | |
| Total | PSTACH | 27675.000 | 140 | | | | | |
| | PSTATT | 486987.00 | 140 | | | | | |
| Corrected Total | PSTACH | 2294.821 | 139 | | | | | |
| | PSTATT | 9858.936 | 139 | | | | | |

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However, statistical results do not provide the same result between the hands-on activities enriched instruction and students' attitude towards science. The hands-on activities enriched instruction did not increase the students' positive attitudes toward science more than the traditional method did.

**Discussion**

The results of this study revealed that hands-on activity enriched instruction increased students' achievement in science more than the traditional instruction did. This result is not surprising considering the fact that many studies indicated hands-on instruction, if regularly incorporated classroom instruction, can enhance students' cognitive achievement (Scharfenberg and Bogner, 2010; Thompson and Soyibo, 2002; Turpin, 2000; Bristow, 2000; Stohr-Hunt, 1996; Freedman, 1997). The study of Stohr-Hunt (1996) investigated effect of frequency of hands-on activities (daily, once a week and once a month) on student's science achievement and they found that students who performed hands-on activities had significant higher scores of science achievement than the students who performed hands-on science infrequently. A similar result was reported by Turpin (2000) who studied with seventh grade students to investigate the effect of an activity-based science curriculum program on science achievement, science process skills and attitude toward science. In this quasi-experimental design, findings showed that science achievement and science process skills of students involved in activity-based program had significantly higher scores as compared with science achievement and science process skills of students who involved the traditional program. Likely, Bristow (2000) reported that science concepts should be learned better when using hands-on teaching methods versus a traditional method. Another important point is stated by researchers that students' alternative conceptions or scientific misconceptions are not eliminated by traditional methods involving primarily lecture (Marinopoulos & Stavridou, 2002; Weaver, 1998), and hands-on activities are an effective way for students to meaningful learning and acquire knowledge (Costa, 2003). According to Cetin (2003), students can be more active learner when they are instructed by hands-on activities in science classrooms, especially if they can apply what they learn in school to their daily life situations. Similar result was reported by McConnell, Steer, and Owens (2003). They reported that collaborative hands-on inquiry activities to be more effective in clarifying conceptual understanding in a comparison of traditional and inquiry based earth science classes. In general, conducting hands-on activities in science classes; for example, in field or laboratory settings, is widely recommended by educational authorities like the National Research Council (2000).

Our second research question focused on the effects of hands-on activities enriched instruction and traditional instruction on students' attitude toward science. The result of present study revealed that there were no significant differences between the experimental and control groups' attitudes toward science. Although some studies have indicated no significant effect of hands-on approach on students' attitudes toward science (e.g., Hardal, 2003; Freedman, 1997; Rowland, 1990), others have reported significant effect of hands-on approach on students' attitudes toward science (e.g., Holstermann, Grube & Bögeholz, 2010; Ornstein, 2006; Thompson and Soyibo, 2002; Gardner & Gauld, 1990; Shymansky, Hedges and Woodworth, 1990). The study carried out by Hardal (2003) indicated that there was no statistically significant difference between students' attitude toward physics in hands-on group and traditional group. Likely, Freedman (1997) investigated the effect of hands-on laboratory instruction on students' attitudes toward science. Students who received a hands-on laboratory experience one period each week for 36 weeks and other ones received no hands-on laboratory experiences. Results showed that there was no significantly difference between the experimental and control groups' attitude toward science. On the other hand, Ornstein (2006) demonstrated that students showed more positive attitudes toward science in hands-on classrooms. Similarly, Thompson and Soyibo (2002) showed that students who instructed with hands-on activities showed more positive attitudes toward chemistry than students who instructed with teacher demonstrations. Another study conducted by Holstermann, Grube and Bögeholz (2010) revealed that students with hands-on experience were likely to report higher interest in the hands-on activities than students without experience. By contrast, the present study was not found similar significant difference between students' attitude toward science in experimental and control group. It is taken into consideration that there are many factors influence student attitudes, such as school and home environments, age, teacher (personality), peers, past experiences and media messages, personal observations etc. (Ornstein, 2006). Moreover, one possible explanation of such a result is that the unit of the study, sense organs, was given to students in three weeks, which may not have been a long enough time period to show a difference in attitude of students between the two teaching methods. To show the ideals of one teaching method over the other, a longer time period may be needed.

In this study, another result was obtained about confounding variables that, gender difference did not have significant effect on both students' science achievement and attitude toward science. The subject of the studies can cause such result. It is known that some subjects of science attract only male student's attention or only female student's attention. Therefore, gender differences could be obtained. However, sense organs of this study have not such property. Both male and female students were interested with the subject. So that gender differences was not significant on dependent variables of this study.

## Conclusion and Implications

Active participation of students and guidance of instructors in science lessons have been emphasized in various theories in education, such as constructivism. The results of the present study suggest that hands-on instruction may enhance a better learning success compared to traditional instruction. Students in hands-on group learned sense organs by both hands-on and minds-on. They were actively engaged and had direct experiences in their learning. Their teachers guide them during their investigations. They performed all hands-on activities and discussed all critical questions to get the important points of the subject at the end of activities. For that reason, they might remember important concepts after years. Besides, these activities make science lessons funny, more enjoyable and efficient for the students. Nevertheless, the students who instructed with traditional method learned sense organs only by listening their teacher and taking notes**.** They did not observe and feel what happen in our body during hearing, tasting, smelling, touching and seeing mechanisms. Based upon observation checklist results, these students got bored during instruction.

One important implication of this study is that teachers need to realize the significance of hands-on instruction on science learning. Since learning environment should include creative and self-motivated teachers to give instruction by hands-on (Harvey, Sirna, & Houlihan, 1998), it is believed that exposing teachers to current scientific issues will encourage them to introduce new, motivational approaches for understanding scientific concepts in their classrooms. They should understand that they do not always need any special laboratory equipment to teach science effectively. Teachers might be able to design practical science lessons to attract students' interest by hands-on activities (Holstermann, Grube & Bögeholz, 2010). In addition, teachers should be aware of how to prepare hands-on activities since these activities should not be as cookbook style. These activities should be both hands-on and minds-on. For this reason, both in-service and pre-service teachers should be informed about what is the meaning and importance of hands-on activities, and how they can be used in science classrooms effectively. Moreover, curriculum developers should prepare and integrate some hands-on activities in science curricula.

As a conclusion, hands-on learning was a good idea to engage students actively in their learning. Furthermore, hands-on activities are inexpensive by using easily obtainable and simple life materials, straight forward and practical to perform in class, adaptable for most of the lessons and science subjects. On the other hand, this study was limited to 140 six grade students in four intact classrooms. For further study, similar researches can be constructed for different science topics, and different grade levels with larger sample size.

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