EFFECT OF HANDS-ON/MINDS-ON ACTIVITIES ON JUNIOR SECONDARY SCHOOL BASIC SCIENCE STUDENTS’ LEARNING OUTCOMES IN OGUN STATE, NIGERIA

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Abstract
This research investigated the effectiveness of hands-on and minds-on activities on Junior Secondary Basic Science Students’ Learning outcomes in Ogun State Junior Secondary Schools. A 2x2 quasi experimental research design was used. The target population was the Junior Secondary School students in Ijebu-Ode local government area of Ogun state. The sample for this study was a total number of one hundred and sixty (160) students in their intact classes from three selected co-educational Junior Secondary Schools in the study area. Two classes were randomly selected from each school to represent One experimental group (Hands-On/Minds-On, HMG) and One control group (Conventional Teaching, CTG). Basic Science Students Achievement Test (BSSAT) and Basic Science Attitudinal Rating Scale (BSAS) were used for data collection. Descriptive statistics of mean and standard deviation and inferential statistics of t test were used to analyze the data collected. The study showed that there were significant differences in students’ academic achievements at the post-test (t=31.77, p< 0.05) and delayed post-test levels (t=25.72, p< 0.05), with the students in HMG performing better than students in CTG. This study also showed that students in the HMG had significant positive attitudes (t=33.73, p< 0.05) towards Basic science after the treatment. The authors recommended that Hands-on classroom activities are just one component which when coupled with active learning will make students effective and efficient learners.

Keywords: Hands-on, Minds-on, Basic science, Conventional-lecture, Attitude

Introduction
Science education plays a vital role in the lives of individuals and the development of a nation scientifically and technologically (Alebiosu & Ifamuyiwa, 2008). It is widely and generally acknowledged that the gateway to the survival of a nation scientifically and technologically is scientific literacy which can only be achieved through science education. Nigerian government, aware of the
importance of science education, in National Policy of Education (NPE, 2004) came up with a policy that 60 percent of the students seeking admission into the nation’s Universities, Polytechnics, and Colleges of Education should be admitted for science-oriented courses, while 40 percent of the students should be considered for Arts and Social science courses (Ajibola, 2008). Educators understand that changes in student learning outcomes must be supported by parallel changes in curriculum and instruction. However, it is apparent that many of today’s teachers are caught in the midst of a change for which they may not have been professionally prepared. Many teachers were educated in the classrooms where the role of the student was to memorize information, conduct well-regulated experiments and were then tested on their ability to repeat these tasks or remember specific facts (Dogru & Kalender, 2007).

Basic science, formerly known as Integrated Science, is the first form of science a child comes across at the Nigerian secondary school level; hence basic science prepares students at the Junior Secondary School level for the study of core science subjects at the Senior Secondary School level (Olarewaju, 1994). This implies that for a student to be able to study single science subjects at the Senior Secondary School level successfully, such student must be well grounded in basic science at the Junior Secondary School level. In view of this, Basic Science is given great emphasis in the Junior Secondary School curriculum. The principal reasons why Nigerian Government started Basic Science teaching in Nigerian secondary schools are as follow:

1. It provides students at the Junior Secondary School level a sound basis for continuing science education either in single science subjects or further integrated science;
2. It enhances the scientific literacy of the citizenry;
3. It allows students to understand their environment in its totality rather than in fragments;
4. It allows the students to have general view of the world of science;
5. The processes of science serve as unifying factor for the various science subjects. It is necessary for the learner to know these processes through integrated approach of learning science (Federal Ministry of Education, FME, 2014).

In an attempt to improve the standard of science teaching and learning, a lot of research studies had been carried out. Studies in Basic science education have reported that many students at the Junior Secondary School level have developed negative attitudes towards the subject (Akpan, 1996). Many of the students at this level, because of their dismal performance in the subject, are not benefiting much from the Basic Science curriculum (Balogun, 1992; Olagunju, 1995; Olarewaju, 1999; Odetoyinbo, 2000 Afuwape, 2003; Afuwape & Olatoye, 2004). This, according to Afuwape and Olatoye (2004), has prevented many of them from offering core science subjects or performing better in the core science subjects at the Senior Secondary School level. The numerous science teaching strategies we have today emanated from the design of many curriculum packages in science.
There exist various teaching strategies in science teaching aimed at developing skills in students (Bilesanmi-Awoderu, 2000; Alebiosu, 2003). The strategies recommended for teaching Basic Science centred on discovery strategy (guided inquiry and self-directed inquiry), problem-solving, and laboratory intervention (Olarewaju, 1994; Ojediran, Oludipe & Ehindero, 2014). While Basic Science curriculum planners favour these approaches, experience from teaching practice supervisions revealed that the teachers, who are at the implementation level, favour the conventional lecture approach. Experience from teaching practice exercises has shown that when teachers at this level teach Basic Science, they do so using the conventional lecture approach.

The Basic Science, formerly Integrated Science, curriculum is child-centred and emphasis is laid more on learning science as a process than as a body of knowledge (Olarewaju, 1994). Hence, teachers should actively involve students in the teaching and learning of basic science. However, in reality, very few Basic Science lessons are taught using student-centred approaches such as ‘hands-on and minds-on activities’. Most lessons are conducted based on teacher-centred approach (Saroja & Wan Zi Chan, 2014). One of the reasons is because of the teachers’ beliefs and experiences in school which have influenced them in a way to practice this approach (Jones & Wyse, 2004). According to Woolnough (1994), although, it is satisfying to see the high achievements of students when the teacher-centred approach is used in schools, nevertheless, students’ emotional interest in learning should also be taken into account as it is fundamental to boost their intrinsic motivation, their commitment, their enjoyment and creativity in science. This study claims that hands-on and minds-on activities, without requiring specific expensive materials, can be one of the interactive engagement methods. Therefore, the main purpose of this study is to develop hands-on/minds-on activities that can raise learning outcomes of junior secondary schools Basic Science students in Ogun State.

**Literature Review**

Science begins for children when they realise that they can learn about the world and construct their own interpretations of events through their actions and experience (Ozlem & Ali, 2011). “A child best learns to swim by getting into water; likewise, a child best learns science by doing science” (Rillero, 1994). Doing science, as opposed to simply hearing or reading about it, engages students and allows them to test their own ideas and build their own understanding (Ewers, 2001). Therefore, it is difficult to imagine a science-teaching program without doing science experiences (Ozlem & Ali, 2011). Children can learn mathematics and sciences effectively even before being exposed to formal school curriculum if basic Mathematics and Science concepts are communicated to them early using activity-oriented (Hands-on) method of teaching (Ekwueme, Ekon & Ezenwa-Nebifé, 2015). Mathematics and Science are practical and activity-oriented and can best be learnt through inquiry (Manor, 2002) and through intelligent manipulation of objects and symbols (Ekwueme, 2007).
Hands-on-approach is a method of instruction where students are guided to gain knowledge by experience. This means giving the students the opportunity to manipulate the objects they are studying, for instance, plants, insects, rocks, water, magnetic field, scientific instruments, calculators, rulers, mathematical set, and shapes (Ekwueme, Ekon & Ezenwa-Nebife, 2015). In fact, it is a process of doing mathematics and science where students become active participants in the classroom. Haury and Rillero, 2015 posit that hands-on learning approach involves the child in a total learning experience which enhances the child’s ability to think critically. It is obvious, therefore, that any teaching strategy that is skilled towards this direction can be seen as an activity-oriented teaching method (Hands-on-approach). Unlike the laboratory works, hands-on activities do not necessarily need some special equipment and special medium. According to Jodl and Eckert (1998), hands-on activities are based on the use of everyday gadgets, simple set-ups or low-cost items that can be found and assembled very easily.

Hands-on-approach has been proposed as a means to increase students’ academic achievement and understanding of scientific concepts by manipulating objects which may make abstract knowledge more concrete and clearer. Through hands-on-approach, students are able to engage in real life illustrations and observe the effects of changes in different variables. It offers concrete illustrations of concepts. This method is learner-centred which allows the learner to see, touch and manipulate objects while learning as mathematics are more of seeing and doing than hearing; so also with science that advocates “do it yourself”. On the contrary, Ekwueme and Meremikwu (2010) observed in their study that some teachers object to the use of interactive activity-oriented method stating that it is time consuming and do not permit total coverage of the syllabus. Fortunately, the new basic science syllabus’ coverage is determined by how much skills/knowledge students’ have acquired rather than how much of the syllabus is covered as learner centeredness is highly advocated.

Obanya (2012) in his convocation lecture confirmed the above statement by adding that the average retention rate of learning by lecture is 5% while that of practice by doing (Activity-oriented) is about 75%. It can be seen that retention rate increases progressively with the use of more interactive and activity-oriented teaching methods (NERDC, 2008). For students to truly learn science concepts, they both need practical opportunities to apply knowledge and also need help in integrating or exchanging the knowledge they gain (Ozlem & Ali, 2011). Students should have minds-on and/or heads-on experiences during hands-on activities. While doing hands-on activity, the learner is learning by doing but while minds-on learning, the learner is thinking about what he or she is learning and doing. Hofstein and Lunetta (1982) state that a minds-on science activity includes the use of higher order thinking, such as problem solving compared to the hands-on activity. Therefore, students should be both physically and mentally engaged in activities that encourage learners to question and devise temporarily satisfactory answers to their questions (Victor & Kellough, 1997).
Several studies in the literature show that hands-on activities help students to outperform students who follow traditional, text-based programs (Freedman, 1997; Stohr-Hunt, 1996; Turpin, 2000; Ozlem & Ali, 2011; Munir & Mumtaz, 2013; Saroja & Wan Zi Chin, 2014; Ates & Eryilmaz, 2011; Akhtar, 2013; Prokop Dieser & Bogner, 2016; Hussain & Fancovicova, 2017; Guner, 2018), to enhance their understanding and replace their misconceptions with the scientific ones (Coştu, Ünal & Ayas 2007; Ünal, 2008), to develop attitudes toward science positively (Bristow, 2000; Bilgin, 2006; Kyle; Saroja & Wan Zi Chin, 2014), and to encourage their creativity in problem-solving, promote student independence, improves skills such as specifically reading, arithmetic computation, and communication (Haury & Rillero, 1994). (Lebuffe, 1994; Ekwueme, Ekon & Ezenwa-Nebife, 2015) emphasize that children learn better when they can touch, feel, measure, manipulate, draw, make charts, record data and when they find answers for themselves rather than being given the answer in a textbook or lecture. Freedman (1997) and Turpin (2000) carried out their study on the effects of hands-on instruction on science achievement and attitude towards science. They concluded that the students in hands-on laboratory instruction or activity-based science curriculum had significantly higher scores compared to students using a traditional science curriculum. However, no significant differences in students’ attitude towards science were found in their study. Bristow (2000) examined whether sixth grade children learn science concepts better when taught using hands-on teaching methods versus a traditional approach. As a result of her study, there was no significant difference between the performances of the groups.

Statement of the Problem

It has been observed that most Basic Science lessons are conducted based on teacher-centred approach. Teachers’ beliefs and experience have been a major influencing factor towards the use of this approach. This teacher-centred approach to teaching basic science concepts has made many students at the Junior Secondary School levels to develop negative interest in Basic Science. This has also affected their academic performance which discourages them from choosing science-oriented courses at the tertiary education level. Very few Basic Science lessons are taught using student-centered approaches, as recommended by the Basic Science curriculum planners, such as ‘hands-on and minds-on activities. These approaches are supposed to inculcate into the students the vital aspect of science teaching and learning which include development of skills, knowledge and attitude. This could be developed through effective hands-on and minds-on activities which when adopted by teachers as one of the teaching approaches in Basic Science lessons, students at the Junior Secondary School level may perform better and develop positive attitude in Basic Science. Given this, the researcher carried out this study to examine the impact of hands-on and minds-on activities in basic science lessons on students’ academic achievement and attitudes towards basic science.

Objectives of the Study

The specific objectives of the study include;

i. compare academic achievement of students exposed to hands-on/minds-on activities and conventional-teaching method in Basic Science in the study area;
ii. compare attitude of students exposed to hands-on/minds-on activities and conventional-teaching method towards Basic Science.

iii. compare the retention ability of students exposed to hands-on/minds-on activities and conventional-teaching method in Basic Science; and

Hypotheses
The following null hypotheses were formulated for this study:

1. There is no significant main effect of hands-on/minds-on activities and conventional-teaching-method on academic achievement of students in Basic Science in the study area.

2. There is no significant main effect of hands-on/minds-on activities and conventional-teaching method on attitude of students in Basic Science in the study area and

3. There is no significant main effect of hands-on/minds-on activities and conventional-teaching method on retention ability of students in Basic Science in the study area.

Methodology
The main purpose of this study was to investigate the impact of hands-on and minds-on activities on students’ academic achievement in and attitudes towards Basic Science. This study employed a 2 x 2 quasi-experimental design. This implies that the design included two instructional groups: One experimental groups - Hands-/Minds-on activities; and the conventional teaching method (control group); and Basic Science Attitude at two levels – favorable and unfavorable. The target population for this study was the Junior Secondary III (JSIII) students in Ogun State.

The sample for this study was the total number of one hundred and sixty (160) students in the intact classes used in the selected co-educational Junior Secondary Schools. Selection of the schools was dependent on the availability of Basic Science teachers, the distance of the schools to one another in order to remove contamination effect, and willingness of school principals and teachers to cooperate and participate in the study. Stratified random sampling was used to select the four co-educational Junior Secondary Schools from the total number of co-educational Junior Secondary Schools that met the aforementioned criteria in Ijebu-Ode, Ijebu North – East, and Odogbolu Local Government Areas of Ogun State. One of these schools was used for the trial testing in order to validate the instruments, while the remaining three schools were used for the main study. In selecting the schools, all the co-educational Junior Secondary Schools in the above-mentioned local government areas that met the laid down criteria were assigned numbers which were written on pieces of paper. These papers were rolled and put into a container, one rolled paper was picked after mixing up the papers, and the picked one was not replaced before picking another one. This method of random sampling led to selection of four schools (one for trial testing and three for the main study).

Two Intact classes were used in each of the selected schools because most of the school principals did not want distortion in their normal school arrangement. For the first school, twenty eight students were
used for the experimental group while twenty five students were selected in the control group making a total of fifty three students, for the second junior secondary school, twenty nine students were found in their intact class for the experimental group while twenty four students were involved in the control group making a total of fifty three students while twenty eight students were found in the experimental group while twenty six students were involved in the control group making a total of fifty four students. This made a total of eighty five students in the experimental group and seventy five students in the control group.

The basic science topics used during classroom teaching, using any of the teaching strategies, were three topics in basic science, which they had not been exposed to before the experiment. These are sink and float, balance and making magnet. In order to collect data for the study, the following instruments were developed, validated and used:

i. The Hands-on/Minds-on Learning Guide (HMLG) for teachers and students.

ii. Basic Science Student Achievement Test (BSSAT).

iv. Basic Science Attitudinal Rating Scale (BSARS).

*The Hands-on/Minds-on Learning Guide (HMLG) for Teachers*

**Activity 1: Sink or Float**

For this experiment, all you need is a bowl of water, a cork, a stone, a coin, and a grape. Have students first predict what items will float and what items will sink in the water. Then have groups of students observed as they place the items in the water one by one.

**Activity 2: Balance**

Using a string, have students hang two plastic cups off of a hanger that’s hanging from a doorknob. Have them place items into each cup to learn about balance and see which one is heavier and why.

**Activity 3: Making magnets**

You can make your own magnet as follows:

Use one pole of strong magnet, use a thin rod or iron. Stroke your rod with the pole of your magnet. follow the stroke pattern show to them.

*Basic Science Student Achievement Test (BSSAT).*

This was a test of students’ achievement in basic science. The concepts examined were based on the three topics in basic science scheme of works. Students have not been taught the selected topics. The test items of forty multiple choice questions were adopted from the past questions of Junior Secondary School Certificate Examination (JSSCE) in basic science in Ogun state. The JSSCE questions are standardized in nature because they have been field-validated by the experienced test and measurement experts in the state ministry of education. Moderating Committee edited and selected good items.

*Basic Science Attitudinal Rating Scale (BSARS)*
The instrument was the adapted 14-item Biology Attitude Rating Scale by James Russell and Steven Hollander (2011). All the 14 items were relevant to basic science; hence the basic science rating scale contained 14 items. The instrument was to find students’ attitudes for learning basic science at the Junior Secondary School level. There were two sections in the questionnaire; section A sought for demographic data of students, while section B consisted of 14 items which students responded to by expressing their level of agreement or otherwise on a 5-point Likert-type scale ranging of 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, and 5 = strongly agree.

For the validation and reliability of BSARS, it was trial tested by administering it to forty students from an intact class of a co-educational Junior Secondary School III (JSS III) different from the selected schools for the main study. The reliability of the instrument was determined by using Cronbach coefficient alpha which was found to be 0.92. Copies of the Achievement Test for Basic Science Students (ATBSS) were given to specialists in the field of Basic Science and science education to establish the content and face validity. They read through and input the necessary corrections in respect of the structure of each item, and the category under which each item would be placed. They also passed their comments and suggestions about the language to be used in the instrument. The instrument was also given to three English and Basic Science teachers from different Junior Secondary Schools in order to make the instrument readable and understandable to the target population. After marking the students’ scripts, item analysis of the test items was carried out in order to determine the difficulty and discrimination indices of the test items. The difficulty index of the test items ranged between 0.19-0.74, while the discrimination index ranged between 0.00-0.41. To determine the reliability of ATBSS, the achievement test was trial tested by administering it to forty students from an intact class of a co-educational Junior Secondary School different from the selected schools for the main study. Spearman - Brown co-efficient was used to determine the reliability co-efficient of the instrument, which was found to be 0.81.

The Researcher sought for the permission of the principals of the selected schools. The participating teachers were motivated and encouraged in order to obtain their maximum cooperation. One week training programmes was organized for teachers and students on successful and productive hands-on and minds-on activities. Participating teachers in the experimental group were exposed to comprehensive training programmes so that they do not deviate from the instructional principles and procedures governing the experiment. The students that were used as experimental subjects were exposed to orientation activities on hands-on and minds-on activities. Both the participating teachers and the researcher addressed the students in their classrooms. There were four phases of data collection. These were the pretest – first one week, treatment – three weeks, the immediate academic achievement test – one week, and the delayed academic achievement test –within the last two weeks of the seven weeks. The essence of delayed academic achievement test was to find out whether students were able to retain the basic science concepts taught. Three periods of 40 minutes each were spent each week for
the three weeks. There was no alteration on the time-table allocated for basic science by the school, i.e.
the periods were in line with the schools’ time-tables.

Pretests
Before exposing the selected students for the study to the different strategies, the students were given
the questionnaire on attitude for their responses, followed by the thirty multiple choice test, which was
given to the students to answer.

Treatment
There were one experimental group and one control group. Students in the experimental group were
taught using the hands-on/minds-on activities, while students in the control group were taught using the
conventional-teaching method.

Immediate academic achievement test
The immediate academic achievement test was administered within the week after the completion of
the treatments; this was to minimize maturation effect, by giving the students the same thirty – items
– multiple choice test that was used for the pretests.

Delayed academic achievement test (Retention)
The delayed academic achievement test (delayed post-test) was conducted two weeks after the
administration of the immediate academic achievement test (post-test). The same test items that were
used for the immediate academic achievement test were also used for the delayed academic achievement
test. The test items were rearranged to give a vague impression that the delayed academic achievement
test items were different from the immediate academic achievement test items.

During the experiment, the following precautions were taken:

1. The same set of participating teachers was used throughout the study in order to eliminate
   variation due to instrumentation.
2. Attendance of students was taken at the beginning of every teaching session; scores of students
   who missed any of the sessions were not used for data analysis.
3. Students in experimental and control groups were given equal time of treatment and
   observations.
4. The test items of the pretests were rearranged to give a vague impression that it was a new set
   of test items at both the pre test and delayed posttest levels. The color of the test paper was also
   changed. The afore-mentioned points prevented the students from being familiar with the
   questions of the pre-test, post-test, and delayed post-test instruments.
5. The time allowed for the pre-test, post-test, and delayed post-test was the same.

Data Analysis
The data collected from the administration of the instruments were analyzed using the descriptive and
inferential statistical techniques. Descriptive statistics, which involved the computation of the pre-tests,
post-tests, and the delayed post-tests mean scores and standard deviation for each of the dependent
variables and Inferential statistics, which involved using t test to compute each dependent variable for the two instructional groups in order to test for possible post experimental differences in the dependent variables with respect to methods and attitude. Computations for the afore-mentioned methods of data analysis were done using SPSS 16.00.

**Results**

**Ho1:** There is no significant main effect of hands-on/minds-on activities and conventional-teaching method on academic achievement of students in Basic Science in the study area.

<table>
<thead>
<tr>
<th>Test</th>
<th>Group</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>df</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>HandsOn</td>
<td>85</td>
<td>10</td>
<td>15</td>
<td>11.94</td>
<td>1.91</td>
<td></td>
<td>1.048</td>
<td>&gt;0.05</td>
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<td></td>
<td>Lecture</td>
<td>75</td>
<td>10</td>
<td>15</td>
<td>11.60</td>
<td>1.46</td>
<td>158</td>
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<td>Total</td>
<td></td>
<td>160</td>
<td>10</td>
<td>15</td>
<td>11.78</td>
<td>1.71</td>
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<tr>
<td></td>
<td>HandsOn</td>
<td>85</td>
<td>10</td>
<td>15</td>
<td>31.06</td>
<td>2.92</td>
<td></td>
<td>31.71</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td></td>
<td>Lecture</td>
<td>75</td>
<td>15</td>
<td>22</td>
<td>18.13</td>
<td>2.11</td>
<td>158</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>160</td>
<td>15</td>
<td>35</td>
<td>25.00</td>
<td>6.96</td>
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</table>

Table 1 shows the scores of students in hands-on/minds-on activity group (HMG) and those in conventional lecture group (CTG). According to the table, the mean score of students in HMG, at the pre-test level, (N=85, M=11.94, SD=1.905) is slightly higher than the mean score of students in CTG (N=75, M=11.60, SD=1.461). In the same vein, the standard deviation of students in HMG was higher than those of the students in CTG. The dispersion of scores from mean score by students in HMG was higher than those of students in CTG. Consequently, it was concluded that Standard Error of Measurement (SEM) of students in CTG was lower than those of the students in HMG, this implies that students in CTG had more consistent scores at the pre-test level. At the post-test level, the mean score of students in HMG was (N=85, M=31.06, SD=2.917) higher than the mean score of students in CTG (N=75, M=18.13, SD=2.107). In the same vein, the standard deviations of students in HMG is higher than the standard deviation of students in CTG. The dispersion of scores from mean score by students in HMG was higher than those of the students in CTG. Hence Standard Error of Measurement (SEM) of students in CTG was lower than those of students in HMG, this implies that students in CTG had more consistent scores while students in HMG had less.

It was also shown that there was no statistically significant difference in the pretest scores of the respondents (t=1.048, p>0.05) but the difference between the HMG students’ post test scores and CTG students’ post test scores was statistically significant, (t=33.17,p< 0.05). Hence the null hypothesis is rejected.

**Ho2:** There is no significant main effect of treatment (hands-on/minds-on and conventional-teaching) on attitude of students towards basic science.
Table 2: t-test comparing students’ attitudes in HMG and CTG before and after the Treatment.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>df</th>
<th>T</th>
<th>p</th>
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<td><strong>Pre-attitude</strong></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Hands On</td>
<td>85</td>
<td>2.24</td>
<td>1</td>
<td>5</td>
<td>1.360</td>
<td>0.147</td>
<td></td>
<td>-0.021</td>
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<td>1</td>
<td>5</td>
<td>1.498</td>
<td>0.173</td>
<td>158</td>
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<tr>
<td>Total</td>
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<td>1</td>
<td>5</td>
<td>1.422</td>
<td>0.112</td>
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<tr>
<td><strong>Post-attitude</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hands On</td>
<td>85</td>
<td>4.58</td>
<td>4</td>
<td>5</td>
<td>0.497</td>
<td>0.054</td>
<td></td>
<td>25.73</td>
<td>&lt;0.05</td>
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<td>Lecture</td>
<td>75</td>
<td>1.51</td>
<td>1</td>
<td>4</td>
<td>0.860</td>
<td>0.099</td>
<td>158</td>
<td></td>
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<td>Total</td>
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<td>3.14</td>
<td>1</td>
<td>5</td>
<td>1.684</td>
<td>0.133</td>
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</tbody>
</table>

Table 2 shows the mean scores of students’ attitudes towards Basic Science before and after the treatment. According to the table, the mean score of students’ attitudes in HMG (N = 85, M = 2.24, SD = 1.360) before the treatment was slightly higher than the mean score of students’ attitudes in CTG (N = 75, M = 2.16, SD = 1.498). In the same vein, the standard deviation of students’ attitudes in HMG was lower than those of the students in CTG. After the treatment, the mean score of students’ attitudes in HMG (N = 85, M = 4.58, SD = 0.497) was higher than the mean score of students’ attitudes in CTG (N = 75, M = 1.51, SD = 0.860). However, there was an increase in the score of students exposed to the two groups as the post attitude of those exposed to the HMG was much higher after the treatment was administered.

Table 2 also revealed that the difference between students’ attitudes was statistically significant after the treatment (t=25.73, p< 0.05) but not significant before the treatment. (t=-0.021, p> 0.05) hence, the hypothesis that states that there is no significant difference in the attitude of students exposed to the strategies was rejected as the post attitude revealed a difference. It could be concluded that there is a statistical main effect of HMG and conventional method on the attitude of students in the study area.

**H03:** There is no significant main effect of treatment (hands-on/minds-on and conventional-teaching) on retention of students in basic science in the study area.
Table 3: t-test of main effect of treatment on students’ retention

<table>
<thead>
<tr>
<th>Test</th>
<th>Group</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>df</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dposttest</td>
<td>HandsOn</td>
<td>85</td>
<td>28</td>
<td>35</td>
<td>32.24</td>
<td>2.328</td>
<td>158</td>
<td>33.17</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td></td>
<td>Lecture</td>
<td>75</td>
<td>10</td>
<td>15</td>
<td>12.87</td>
<td>1.941</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>160</td>
<td>10</td>
<td>35</td>
<td>23.16</td>
<td>9.931</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At the delayed post-test level, the mean score of students in HMG was (N=85, M=32.24, SD=2.238) higher than the mean score of students in CTG (N=75, M=12.87, SD=1.941). In the same vein, the standard deviations of students in HMG is higher than the standard deviation of students in CTG. The dispersion of scores from mean score by students in HMG was higher than those of the students in CTG. Hence Standard Error of Measurement (SEM) of students in CTG was lower than those of students in HMG, this implies that students in CTG had more consistent scores while students in HMG had less consistent scores. Talking about the performance of students in Basic Science at the delayed post-test, i.e. retention table 3 revealed that the difference between the HMG students’ scores and CTG students’ scores was statistically significant \( t=33.17, p< 0.05 \). Hence the null hypothesis is rejected.

Conclusion
This research sets out to find out the effectiveness of Hands-on and Minds-on activities on Junior Secondary School students’ academic achievements. Finding of this research showed that there was no statistically significant difference between the scores obtained by the students in both HMG and CTG at the pre-test level. However, there was statistically significant difference between the scores obtained by the students in HMG and CTG at the post-test level. Students in HMG scored higher marks than their colleagues in CTG at the post-test level. This finding is in line with the findings of Staver and Small (1990); Stohr-Hunt (1996); Turpin (2000); Coştu, Ünal and Ayas (2007); Ünal (2008); Ozlem and Ali (2011); Munir and Mumtaz (2013); Evelyn and Saroja (2014); Ates and Eryilmaz (2011); Prokop Dieser and Bogner (2016); Hussain and Fancovicová (2017); Guner (2018). This finding contradicts the finding of Bristow (2000), who found no significant difference in the performance of students in HMG and CTG. Talking about the retention of basic science concepts taught, students in the HMG scored higher marks in the delayed post achievement test than the students in the CTG. This might be due to the fact that students in CTG were actively involved in the teaching and learning process, hence the concepts taught formed a mental picture in their minds, enhanced their understanding and replaced their misconceptions with the scientific ones; which made it difficult for them to forget the basic science concepts taught.

This study also aimed at finding out if the attitudes of students in both HMG and CTG changed after the treatment. Finding of this study revealed that hands-on/minds-on activities had significant positive effect on the attitude of students in CTG towards basic science. Many of the students in CTG, who had
negative attitudes towards basic science before being taught using hands-on/minds-on activities, had positive attitudes towards basic science after being taught using hands-on/minds-on activities. Reverse was the case with many of the students in CTG. Many of them maintained their negative attitudes towards basic science, after being taught using CTG. This might largely due to the fact that they were not actively involved in the teaching and learning process, hence the concepts taught were more abstract in nature to them. This finding is in line with the findings of Jaus (1977); Bredderman (1983); Schibeci and Riley (1986); Bonnstetter, and Gadsten (1988); Bristow (2000); Bilgin (2006); NERDC (2008); Obanya (2012); Kyle, Evelyn and Saroja (2014), who all found that hands-on and minds-on activities help students to develop positive attitudes towards science positively. However, this finding contradicts the finding of Freedman (1997) and Turpin’s (2000), who concluded that the students in hands-on laboratory instruction or activity-based science curriculum had significantly higher scores compared to students using a traditional science curriculum. However, no significant differences to students’ attitude towards science were found in their study.

Recommendations
Based on the findings of the study, the following recommendations were made;

1. Studies show that students learn best when learning is active, when they are engaged in hands-on classroom activities, and involved in what they are learning. In fact, scientists believe that when children use all of their senses, it helps the brain create pathways that make it easier and quicker to retain information. Brain scans show that students who took a hands-on approach to learning had activation in sensory and motor-related parts of the brain. This study has shown that students’ academic achievements improved when taught using hands-on and minds-on activities and they developed positive attitudes towards basic science.

2. Basic science teachers should be flexible in their choice of teaching methods, i.e. teachers should use combinations of one or two methods, most especially hands-on/minds-on activities, in order to enhance his/her teaching.

3. It easy to incorporate hands-on activities into basic science subject teaching and learning process. Hands-on classroom activities are just one component to help improve student learning. When a basic science teacher couples that with active learning, students will become more effective and efficient learners.

References


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