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Comparative Analysis of the Effects of Inquiry Based and Non-Inquiry Based Multiple Intelligence Approach on Pupils' Interest in Science

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Abstract

The study was a comparative analysis of the effects of inquiry-based and non-inquiry based multiple intelligence approach on pupils' interest in learning science. The study employed a quasi-experimental research design that used two intact classes of thirty (30) pupils each assigned to two groups, the inquiry-based group (A) and a non-inquiry based multiple intelligence approach group (B). A pre-test was administered in the subjects before the intervention using the adopted questionnaire (ISLQ) for surveying pupils' interest in learning science. The reliability of the eighteen (18) item questionnaire (ISLQ) was establishment at 0.76 by Cronbach Alpha. Treatment on the two groups was carried out for a period of eight (8) weeks after which a post-test was conducted using the reshuffled instrument (questionnaire). The study employed a quantitative analysis of descriptive statistics and inferential statistics in a bid to compare the effects of the two teaching approach. The mean, median and standard deviation with the ANCOVA were found suitable statistical test for comparing the effects of two different interventions as well as to confirm of there exist any statistically significant difference for the mean variables between the two groups after controlling newly formed defendant variables means on one or more covariates were used. Result shows that the inquiry-based multiple intelligence approach was better in arousing pupils' interest to learning science. The study therefore recommended the introduction and use of the inquiry- based multiple intelligence approach into primary, secondary and tertiary institutions to enhance students interest's in learning science to fruition.

Key words: Multiple Intelligence, Inquiry, Interest in Science.

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Introduction

Interest is often thought as a process that contributes to learning and achievement in science in other fields of endeavors (Harackiewicz & Hullerman, 2010). Indeed the role of interest in promoting achievement in science at the primary, secondary or tertiary levels of education cannot be over- emphasized. Walsh (2004) also affirms that interest in science among students is a strong predictor of achievement. According to Harackievwicz et al (2010) interest in something refers to what someone cares about. Interest can be categorized into two components namely individual interest and situational interest. Individual interest in more momentary and often situational bound. Teachers method of teaching in the class may either arouse learner' interest or mar it. Pedagogic process too engaged by the science teacher can make learners to create and sustain interest in science or destroy or decrease interest in a student.

Fortner (2006) has reported the declining number of students who pursuit science related studies are due to low interest in learning science. The younger students has better learning interest in learning science compared to their older counterparts (Emendu & Udongu. 2013)As the students grow older they tend to dislike science due the reducing curiosity towards science experiments lead the students from entirely develop their scientific literacy. Interest driven in learning experiences increases the students' interest in learning science so that Yetisir (2014) argued that students' interest towards learning science can be enhanced through involving them in inquiry based activities and hands-on activity.

Inquiry-based science instruction is a major goal of science reform (Bulunuz, 2007). Although inquiry in science education is relativity new, its pedagogical origin can be traced back to Aristotle and Plato the classical philosophers. The central strategy for teaching science in schools is science as inquiry. Inquiry Based Learning involves a systematic process of natural or material world trigger to initiate questions, find new things and testing it to obtain new array of knowledge (Ekeyi, 2013). It is geared by an individual's own curiosity, wonder and passion to solve any emerging problem and communicate the received knowledge. Inquiry is the ground where learner constructs a new mental framework of the natural or material world. Inquiry learning approach is making meaning of experience. Kaya (2008) stated inquiry based learning can be conducted effectively by embedding 5E learning cycle. 5E learning cycle is seen as guided inquiry where students are supposed to design their own procedure with given materials and problems to solve the emerged problem with teacher acting as facilitator (Thompson & MacDougall, 2002). 5E learning model comes with strong constructivist foundations. This learning cycle comes with 5 phases which are engagement, exploration, explanation, elaboration and evaluation (Temur, 2009).

Although inquiry based approach should be incorporated into science teaching, Schwartz & Wasserman (2001) has stated when students' learning desire is not align with the teachers' teaching style, it does not only reduces students' achievement but it leads to negative attitude in class and decrease the students' motivation to learn. This is further supported by Goodnough (2011) who stated when the teaching style used by the teachers fail to support students' cognitive development it will affect the teaching and learning process. Students are unable to perform in a subject when the instructional strategy used by the teachers fails to fulfil the preferred learning style of the students (Dunn, 200). Therefore an instructional strategy which favours teachers not necessarily will motivate students to learn. According to Britner & Pajares (2001) when the instructional strategy used by teachers does not align with the students' preferred learning style it will affect them mentally and physically.

The multiple intelligence theory was initiated by Gardner (1983) who asserts that the theory is based on the theory of constructivism and that there are eight (8) intelligences such as verbal linguistic, mathematical logical, spatial visual, musical, interpersonal, bodily kinesthetic and natural intelligence. Accordingly Gardner (1983) affirmed that multiple intelligence help learners to understand complex concepts. The use of inquiry which makes learners learn by discovery may therefore fit into the approach of multiple intelligences as a way of helping students to learn complex concepts by finding it out by themselves especially learning science with interest and not by compulsion.

Purpose of the Study

The main purpose or objective of this study was to compare the effects of inquiry and non-inquiry based multiple intelligence approach in improving interest towards science among Year 5 pupils. In other words, the study investigated to see what effects the use of inquiry and non-inquiry based multiple intelligence approach as instructional strategies does have on arousing pupils' interest in learning science.

Review of Literature

The literature related to the topic under study is as follows.

Multiple Intelligence

Goodnough (2000) observed that multiple intelligence theory provides a theoretical framework for the students to arrange and carry out science activity. He also asserts that multiple intelligence works as stimulator to diverse teaching activity,

enhance conceptual understanding, and motivates students to learn science thus accommodate the learning expected by the students . In a different study carried out by Sarrazine (2005) has identified that the science teaching using multiple intelligence to study the phases of the moon has tarnished the common misconceptions hold by the students and permits meaningful learning to occur. The understanding of intelligence is a prerequisite to unprecedented improvement in pedagogy so that by adhering to the traditional notion of intelligence, schools only identifies certain skills as basic or essential, and they demean others by tagging them as failures or frills. Invariably school definition of intelligent behaviour make students who do not perform well in mathematical or linguistic disciplines as being irrelevant (Campbell & Campbell, 1999).

The Multiple Intelligence (MI) Theory was developed by the renowned educational psychologist, Howard Gardner, who recognizes that intelligence, can come in many forms. Besides, the MI Theory outlines eight kinds of intelligence in any (one or more) of which a child may demonstrate Excellency namely as: linguistic, musical, logical/mathematical, visual/spatial, bodily/kinesthetic, intrapersonal and interpersonal and natural. Accordingly, Howard Gardner's theory of multiple intelligences clearly describes intelligence as the ability to solve problems, to make culturally relevant contributions to one's community, as well as identifying new challenges. According to Taheri and Zarei (2015); Schwert (2004) and Children's Corner (2000) each of these intelligences as briefly by Howard Gardner's MI Theory are presented as follows:

Linguistic intelligence – This refers to the learners 'sensitivity to the meaning of words, grammar rules and the function of language such as in essay writing;

Musical intelligence – It is the ability to learn from hearing tones, rhythms and musical patterns, pitch and timbre, as in composing a symphony;

Logical / mathematical intelligence – Learners' ability to make use of numbers, make relationships between objects and solve problems, as obtained in calculus and engineering;

Visual / Spatial intelligence – ability to perceive and mimic objects in different forms or contexts, as in impressionist painting;

Bodily / kinesthetic intelligence – Learners using the body, perceptual and motor systems in the brain to solve a problem, as in dancing etc.;

Intrapersonal intelligence – Learning ability to understand and define inner feelings, as in poetry and therapy;

Interpersonal intelligence – sensitivity to the moods, feelings, ability to feelings and actions of others.

Naturalistic Intelligence – Learning from things seen in the environment such as rock, insects flowers etc.

Interest in Science-The Dewey's View

Although studies reveals that Interest is very vital to motivating students to learn, but unfortunately research findings according to Dawson (2000) and Osborne (2003) has shown that as pupils grow in age , there tends to be a decline in their interests in science .Osborne (2003) specifically asserts that although some pupils are very much interested in science but that generally pupils interest in science is fast depleting compared to other subjects in the school and a low interest in science is a major challenge because pupils or students cannot learn science effectively without ample interest.

Besides, few major studies over the years had researched to find out what interest is all about since 1910 and one of these is the Dewey's view. In the view of Dewey, interest simply depicts activity in which objects and self are unified under clear ends. There are three things about interest in Dewey's view the first is interest refers to unified activity (Dewey, 1913). In the view of Dewey, momentary excitement or extraneous sources of motivation are not regarded as genuine interest. This according to him is because in these cases, fact and self to be mastered are not unified. Therefore in Dewey's view, genuine interest is maintenance of a self-initiated activity, through action, of the self-alongside some object or idea (due to the necessity of that object or idea) for the accompaniment of the identification. Secondly, in the view of Dewey, interest is made up of some intellectual property so that when curiosity becomes intellectual, it is translated into interest in such a degree that induces finding out for oneself the solutions to questions Thirdly, according to Dewey (1913) interest is a state in which an individual is totally or entirely engaged until he accomplishes his objective goals so that the state of being totally or entirely engaged or whole-heartedness absorbed in a given activity is known as interest. Generally, interest in some simple activities goes a long way in developing intellectual interest (Dewey, 1933).

Inquiry-based Teaching Approach

According to Jiang and McComas (2015), the term inquiry teaching approach has been used to describe various dramatically different teaching methods involving students' decision-making in one way or another. According to them a quick conclusion should not be made that all forms of inquiry would have the similar effect on students' learning of science. Although Minner, Levy and Century (2010) asserts the effectiveness of inquiry teaching has been supported by various empirical studies in research settings rather than in school environments but Kirschner, Sweller and Clark (2006) observed that there is an all-encompassing and clear evidence that inquiry teaching approach, is less effective and efficient than guidance which is specifically intended to support the cognitive processes required for learning.

Inquiry Based Multiple Intelligence Approach

Inquiry Based Learning involves a systematic process of natural or material world triggered to initiate questions, find new things and testing it to obtain new array of knowledge (Ekeyi, 2013). It is geared by an individual's own curiosity, wonder and passion to solve any emerging problem and communicate the received knowledge. Inquiry is the ground where learner constructs a new mental framework of the natural or material world. Inquiry learning approach is making meaning of experience. Kaya (2008) stated inquiry based learning can be conducted effectively by embedding 5E learning cycle. 5E learning cycle is seen as guided inquiry where students are supposed to design their own procedure with given materials and problems to solve the emerged problem with teacher acting as facilitator (Thompson & MacDougall, 2002). 5E learning model comes with strong constructivist foundations. This learning cycle comes with 5 phases which are engagement, exploration, explanation, elaboration and evaluation (Temur, 2009).

Non-inquiry based multiple intelligence approach

Non-inquiry based multiple intelligence approach involve multiple intelligence activities which are conducted based on linear steps without using 5E learning cycle. The non-inquiry approach does not focus on initiating questions to the pupils on what they have learnt and does not promote doing self-evaluation. The learning goal of non-inquiry based multiple intelligence approach is to conduct activities based on what has been assigned to them.

The study incorporated inquiry into multiple intelligence by making use of the 5E learning cycle which is learning made consisting of five (5) stages of elaboration, engagement, elaboration, exploration, explanatory and evaluation. The first level of 5E learning model is engaging. In the engaging phase objects, experience, events or questions are posed to engage the learners to the lesson. It is more on explicating the pupils' prior knowledge on the lesson which will be taught. The teacher guides the pupils to make connection between the prior knowledge possessed by them with the present knowledge .The pupils were facilitated to make connections between what they know and what they can do and their thoughts organized in line with the lessons activities . . As an example, for logical mathematical phase the pupils were engaged by providing each pair with a toy car. The teacher initiates *what is needed for the toy car to operate*? The teacher asks how many batteries are needed for the toy car to work. The pupils' response should be based on number of battery slots. After the activity the teacher will initiate questions to the pupils. The teacher also scaffolds them to present the importance of the source of energy using their prior knowledge by posting questions such as *"what do you think probably will happen if there is no sun?","How countries like Saudi Arabia generate electricity when there is limited water source?"* and *"what will happen if there is no more supply of fuel on earth?"*.

The second phase in 5E learning model is exploring. Exploring phase permits the pupils to use their prior knowledge to generate new ideas. The pupils design the plan, investigate and organize their idea. The teacher poses questions for the pupils to make hypotheses and predict the solution. In this phase the teacher provides resources for the pupils to conduct preliminary investigation. Mostly, in this phase the pupils are engaged in hand-on activities with guidance from the teacher. The essential task of the teacher in this phase is to provide feedback to the pupils and allow them to do self-reflection and evaluate on their model. Exploring phase displays curiosity and deliberate observations and preserves their own ideas for the next phase. As an example for intrapersonal intelligence *Glowing Candle* activity was used. Each group were provided with 4 equal size of candles, 100ml, 250ml, 500ml and 1000ml beakers, stopwatch and lighter. The pupils lighted up a candle and closed it using 1000ml sized beaker. The time taken for the candle to extinguish was recorded in the given table. The steps were repeated using 500ml, 250ml and 100ml of beaker.

The third phase in 5E learning model is explanation. In this phase the pupils are given opportunity to directly interact with the materials. This phase is a continuation of exploration phase. The pupils are involved in explaining their analysis obtained during exploration. Therefore, it is essential that the pupils are able to make connection their explanations to experience they received during engage and explore

phase. In this phase new concepts and skills are introduced to the pupils. The content knowledge is obtained through their reflective activities. This phase motivates pupils to explain the concepts and processes. This works as a ground for pupils to display their talents and skills. The pupils express their ideas and as well listen attentively to their friends' product. This phase highlights the task of a teacher as a facilitator as he facilitates their misconceptions. As an example for visual spatial intelligence the pupils were involved in hands-on activity. In groups, the pupils measured 2 straws measuring 8cm and cut it. Then, both the straws were stick on the base of the box. The end of the balloon was cut and attached to one of the end of the straw. Two satay sticks measuring 10cm each were measured and cut. Then, it was paste horizontally on the base. The car tyres were made using polystyrene and placed at the end of the stay stick. The car was moved by blowing the balloon. The pupils recorded the speed of the car in the given table.

The fourth phase in 5E learning model is elaboration. Elaboration is the phase where the pupils are involved in activities to utilize the concepts and skills that they have learnt and built in the previous phase. They are engaged in further experience to elaborate and extent the content and skill that they have learnt (McFarlane, 2013) for deeper understanding. This is the phase which allows the misconceptions still hold by the pupils to be corrected to enhance their content knowledge. For musical intelligence, during elaboration phase the pupils are shown pictures of types and sources of energy. The pupils are required to tell the answers verbally. The pupils have to do two separate mind maps on types and sources of energy.

The fifth phase in 5E learning model is evaluation. At the evaluate phase, the teacher evaluated the pupils 'understanding of concepts and skills. This is the phase where the pupils' obtained knowledge, skills and abilities throughout the learning is evaluated. The aim of this phase is to identify whether the instructional goal of the lesson has been achieved and at the same time it provides an opening for the pupils to learn to evaluate their understanding and skills (Liu et al., 2009). The effectiveness of activities conducted to achieve the instructional goal and pupils' development can be evaluated in this phase.

Methodology

The study which compares the effect of inquiry-based and non-inquiry based multiple intelligence approach on pupils interest science employed a non-equivalent quasi-experimental research design as adapted from Campbell and Stanley (1963) as shown in table 1 below.

Table 1
Non-equivalent research design

Group	Treatment		
Experimental Group A (N = 30)	0_1	X_1	0_2
Experimental Group (B)(N= 30)	0_1	X_2	0_2

Where 0_1 = Pre-test
0_2 = Post-test.
X_1 = Inquiry based multiple intelligence approach
X_2 = Non- Inquiry based multiple intelligence Approach

Source: Campbell and Stanley (1963)

Study comprises of year 5 pupils enrolled in primary schools in Larut Matang and Selama district. Experimental group 1 was selected from school A whereby experimental group 2 was chosen from school B. School A and B from the same district area which is Larut, Matang and Selama district. Experimental group 1 consist of 30 pupils and experimental group 2 also consist of 30 pupils who have almost the same ability and socio economic background. This is in line with the observation of Sekaran (2003) that a sample size of 30 to 500 respondents is sufficient for a study. Moreover, Chua (2011) also observed that a minimum sample size of 30 is noted to be appropriate for the experimental research. Therefore, a total of 60 participants in the study was considered appropriate. With the two intact classes of primary five (5) pupils used in the study, each with thirty (30) pupils gave a total of sixty (60) pupils for the subjects in the study.

A pre-test was administered to each of the two groups A (inquiry-based multiple intelligence approach group) and group B (Non- inquiry-based multiple intelligence approach group). The pre-test was to establish their level of equivalence. The instrument used in the study is the questionnaire titled Interest in Science Learning Questionnaire (ISLQ) with the intention of surveying the pupils' interest in learning science. The instrument was adopted from Barmby, Kind, Jones and Bush (2005) which was designed to assist teachers in understanding pupils' interest in science. The questionnaire consist of eighteen (18) items with a three (3) smiley face of No, Yes and Neutral for easy interpretation by the pupils. The reliability of the instrument was established at about 0.76 by Cronbach alpha.

After the pre-test, the pupils were then exposed to the treatment using the intervention strategy of inquiry-based multiple intelligence approach, for group A and Non- inquiry-based multiple intelligence approach for group B in the concept of energy for a period of eight (8) weeks. Treatment activities on the first week was conducted on verbal linguistic intelligence approach, second week was on logical mathematical intelligence, interpersonal intelligence and musical intelligence were

fourth and fifth one respectively. In the sixth week, it was a naturalistic intelligence approach and the seventh and eighth weeks captured activities on kinesthetic and interpersonal intelligence respectively. At the end of the eighth week, post-test was conducted using the same instrument that was used at the pre-test but re-shuffled to elicit responses from pupils on their interest in science using the two approach.

Results and Discussion

The statistical analysis was set at significance level at 0.05. The obtained scores from Interest in Science questionnaire were analyzed using Analysis of Covariance (ANCOVA) in accordance to (Pallant, 2011). According to Pallant (2011), ANCOVA is utilized to explore between the groups while statistically controlling an additional variable which is suspected to be influencing scores on the dependent variable. This additional variable is known as covariate. By using ANCOVA, the statistical analysis used the regression procedures to move the variation in the dependent that is due to the covariate, and subsequently, it performed the normal analysis of variance techniques on the adjusted scores (Pallant, 2011). By discarding the influence of the covariate. ANCOVA could increase the power of the F-test. Consequently, it may increase the likelihood which enables us to detect difference between the groups to be compared. The other justification of using ANCOVA is this study is due to the use of existing groups that were compared, thus, the difference of pre-test scores was considered as the cofounding variable .In the context of the quasi experiment design for this study, pretest score of Interest in Science questionnaire was considered as the covariate for the ANCOVA procedures. The dependent variable was the post-test score of Interest in Science questionnaire whereas the independent variable was the teaching approach, namely: Inquiry-based Multiple Intelligence approach and Non-Inquiry-based Multiple Intelligence approach.

Table 2

The Results of ANCOVA

Dependent variable: post-test mean score of Interest in Science						
Source	Type III sum of squares	df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	641.90[a]	2	320.95	37.64	0.00	0.57
Intercept	1368.02	1	1368.02	160.44	0.00	0.74
Pre-Test	1.64	1	1.64	.19	0.66	.003
Approach	626.64	1	626.64	73.49	0.00	.563
Error	486.03	57	8.53		0.00	
Total	32960.00	60				
Corrected total	1127.93	59				

. R Squared = .569 (Adjusted R Squared = .554)

. Generated using alpha = .05

From the ANCOVA, the effectiveness of Inquiry-based Multiple Intelligence approach and Non-Inquiry-based Multiple Intelligence approach on Interest in Science was compared. The obtained result from the analysis was presented in Table 2. The analysis of ANCOVA showed the F value (1, 57) = 73.49, Mean Square Error = 8.53 and $p<0.05$. This result indicates that there is a significant difference among pupils who experienced Inquiry-based Multiple Intelligence approach and Non-Inquiry-based Multiple Intelligence approach on Interest in Science. The effect size between the Inquiry-based Multiple Intelligence approach and Non-Inquiry-based Multiple Intelligence approach with the post-test mean score was shown by partial eta squared value. The partial eta squared value is 0.56. Therefore, it can be interpreted that the difference between the approaches explains 56% of the post-test mean score of Interest in Science variance after pre-test mean score was statistically controlled. Table 3 below shows the estimated marginal means generated by ANCOVA post-test mean score of Interest in Science for Students in the Inquiry-based Multiple Intelligence approach group is 26.28 which is comparatively higher the post-test mean score of 19.78 for students in the Non-Inquiry-based Multiple Intelligence approach group after the difference in pre-test mean score Interest in Science was controlled. Hence, it was concluded that Inquiry-based Multiple Intelligence approach is effective in enhancing the students' Interest in Science.

Table 3

Estimated marginal means for post-test mean scores of Interest in Science and standard error for Inquiry-based Multiple Intelligence approach and Non-Inquiry-based Multiple Intelligence approach

Dependent variable: post-test mean score for Interest in Science				
Group	Mean	Standard Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Inquiry-based Multiple Intelligence approach	26.28[a]	0.54	25.21	27.35
Non-Inquiry based Multiple Intelligence approach	19.78[a]	0.54	18.71	20.85

a. Evaluated based on covariate in the model: pre-test mean score of Interest In Science = 16.35

The key findings of this research revealed that inquiry based multiple intelligence approach was able to promote pupils' interest towards learning science. This study suggested that student may have the opportunity to study science based on their learning styles which are aligned with the multiple intelligence theory, but, the inquiry part play a role in invoking the curiosity and interest of students to learn

science. According to Keyes (2005) students show high interest in learning science when they are given the opportunity to discuss with their peers and work with their experience to construct their knowledge. Students' interest is enhanced when they realize that science is not abstract but concrete experience (Lantz, 2004). The study conducted by Li, Ruiz-Primo & Shavelesson (2006) revealed that students who took part in inquiry based learning showed interest in learning science compared to those who were taught using non-inquiry method and she concluded that interest is the predictor of success. Similarly. Hoerr, Boggeman & Wallach (2010) reported that Singaporean students became more interested in learning science when the hands-on activities were integrated with inquiry approach where they were able to have peer discussion. In another experimental study conducted by Hofstein (2004) recently, revealed that the female students who demonstrated low interest in learning science participated eagerly in inquiry based labs and they felt motivated to take leadership roles during the experiments. In the same study, it was reported that the students admitted they love to pose questions and find the best solution to the questions initiated.

Conclusion

Science teachers hold a great responsibility in creating a positive learning environment for the students to learn. This is achieved when teachers use the right pedagogies appropriate with the students' type of intelligence but at the same time, able to invoke the curiosity of the students through questioning and reasoning. Through this study it has become evident that inquiry based multiple intelligence is effective to enhance pupils' Interest in Science. However, multiple intelligence all alone is not sufficient to develop pupils' cognitive ability. Multiple intelligence theory needed to be assisted with an efficient teaching approach to make it even fruitful. Therefore, inquiry based multiple intelligence is evidently able to increase the interest in science.

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