ENHANCING SCIENCE PROCESS SKILLS' ACQUISITION IN BASIC SCIENCE: A CASE FOR SIMULATED LABORATORY AND ENRICHED LABORATORY GUIDE MATERIAL EXPERIMENT

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ABSTRACT

Basic Science is a core subject at the basic education level in Nigeria. It is taught to lay foundation for further studies in Biology, Chemistry and Physics. However, students do not acquire science process skills needed to enjoy, experience and develop interest in science subjects because of inadequate exposure to Basic Science practical. Therefore, this study determined the effects of simulated laboratory (SL) and enriched laboratory guide material (ELGM) experiments and examined the moderating effects of gender and future career interest in science on students' acquisition of science process skills in Basic Science. Kolb's experiential learning theory provided the framework while the study adopted the pretest-posttest control group quasi experimental design with a 3x2x2 factorial matrix. A total of 277 (130 males, 147 females; ±17years) junior secondary three students randomly selected from six purposively selected secondary schools based on availability of functional Computer and Physics laboratories participated in the study. Data were collected using Science process skills test in Basic Science (r=0.72) and Future career interest in science (r=0.99). Analysis of covariance, estimated marginal means and scheffé post-hoc analysis were employed to test seven hypotheses at 0.05 level of significance. The study indicates that both SL and ELGM enhanced students' acquisition of science process skills in Basic Science more than the conventional (expository) laboratory experiment. Also, while gender play no significant role, students with science-related future career interest in science acquired science process skills in Basic Science more than those with non-science related. Teachers should be trained in the use of both simulated laboratory and enriched laboratory instructional methods to ensure that students acquire science process skills in the subject.

Keywords: Basic Science, SL, ELGM,

INTRODUCTION

Science and technology continue to contribute to advancement in information and communication, efficient transportation (through air, waters, rails and roads on land), improvement in health-care delivery, among others. Little wonder, nations of the world place emphasis on the teaching and learning of science at all levels of education. According to the Nigerian Educational Research and Development Council (NERDC, 2008 a), Basic Science is a form of science education in Nigeria which was originally one of the twelve (12) compulsory subjects in the upper basic education curriculum (p.6). It replaces Integrated Science of the old junior secondary education curriculum (NERDC, 2008 b:5) as "… a re-alignment and restructuring of the revised curricula for primary and Junior Secondary

Integrated Science (NERDC, 2006:iv). However, it now exists as one of the four components of the Basic Science and Technology in the curriculum for junior secondary education (FRN, 2013:25). Other components are Basic Technology, Physical and Health Education and Information Technology. Basic Science and Technology is one of the ten (10) compulsory subjects in the basic education curriculum (NERDC, revised 2012:iv).

One of the objectives of Basic Science and Technology is "to enable the learners to acquire basic knowledge and skills in science and technology" (NERDC, revised 2012:iv). However, Basic Science is taught without adequate involvement of students in practical works (Ndirika, 2011) through which they could develop requisite skills for undertaking result-oriented inquiry in science (Bulunuz and Jarrett, 2010). Thus, students perceive science as difficult.

Table 1: Transition Rates from Basic Science to the Senior Secondary Chemistry and Physics in Oyo State

BECE Year taken	Population (A)	WASSCE Year taken	Science Population (B)	% Population of BECE graduates who took science subjects (C=B/AX100%)
2008	80,070	2011	15,163	18.9
2009	85,034	2012	13,724	16.1
2010	80,355	2013	27,111	33.7

Source: Department of Planning, Research and Statistics, Oyo State Ministry of Education, Secretariat, Ibadan, Oyo State (2015).

Table 1 indicates that 18.9%, 16.1% and 33.7% of the Basic Science graduates in Oyo State offered and sat for one or both of Chemistry and Physics in the West African Senior School Certificate Examinations (WASSCE). Therefore, secondary school students are not adequately prepared in Basic Science as a foundation subject for further studies in Biology, Chemistry and Physics in the senior secondary school (Ekpunobi, 2005). Literature revealed that Basic Science teachers do not engage students in practical. Most Nigeria public schools have no Basic Science laboratory nor science kits (Nnorom, 2012 and Ajeyalemi 2011), qualified laboratory personnel - technologist, technician, attendant and/or assistant (Taiwo, Adeniji and Muazu, 2012) and teachers' guide and practical manuals (Eya and Elechi 2011) to provide directions on the conduct of experiment.

Foulds and Rowe (1996) submitted that effective science learning and development of science process skills are inseparable activities. Science process skills are expertise needed by a scientist to effectively carry out scientific activities. They are the hubs of scientific discoveries and technological breakthroughs. They have potentials to increase students' achievement and scientific creativity (Aktamiş and Ergin, 2008). The American Associations for the Advancement of Science (AAAS) identified fourteen process skills and these have been grouped into basic and integrated science process skills in the Science-A Process Approach (SAPA) Curriculum project. The basic (simple) science process skills provide a foundation for learning the integrated (more complex) science process skills (Padilla, 1990). The basic skills consists of observing, using space/time relationships, inferring, measuring, communicating, classifying and predicting while the integrated skills include controlling variables, defining operationally, formulating hypotheses, interpreting data, experimenting, formulating models and presenting information. Science process skills could be taught and developed through constant practice in the laboratory (Feyzioğlu, 2009 and National

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Association of Biology Teachers, NABT, 2005). Hence, effective science instruction should promote acquisition of science process skills through regular students' involvement in laboratory activities.

In order to improve science teaching and learning in Nigeria, science educators have suggested the use of some instructional approaches, methods and strategies which they have found to promote students' interest and enhance their achievement in science. Alake (2007) observed gradual development of students' interest in Integrated Science when taught using Floor Puzzle Game (FPG). Opara and Elekalachi (2007) reported that the application of indigenous technology in science teaching makes it more meaningful and thereby captivates the interest of boys and girls in the learning process. However, there are no Basic Science laboratories and laboratory guide material to teach practical in the subject. Thus, students could not acquire adequate science process skills and therefore, have poor foundation in science practical at the basic education level.

In order to make up for this deficiency in previous strategies, Shaheen and Khattab (2005) recommended the use of simulated laboratory (SL) experiments where there are no laboratories and Ogunbowale (2012) advocated the adoption of enriched laboratory guide material (ELGM) experiments where there are functional laboratories to conducting Basic Science practical. Simulated laboratory experiment is an application of computer assisted/aided learning (CAL) to conducting experiments in the laboratory (Akanbi, 2005). It consists of either still or mobile images/models of real apparatus, equipment and materials. These models could be assembled by "drag and drop" using high level programming language such as Action Script and JavaScript. It affords students the opportunity to observe, measure, input and store values of the variables during the experimental procedure. It is available online or as stand-alone application package in compact disc (CD)-ROM, digital video disc (DVD) among others (Saka, 2005).

Stand-alone application packages are not affected by limited internet connectivity and other challenges associated with using online simulations. This is because 'stand-alone applications are computer programmes that run without connection to telephone, television, satellite or other electronic transmissions' (Olutunmbi, 2004). Thus, it was adopted, developed and used in this study. Basic Science Simulated Laboratory Experiments Software Package (BSSLESP) was developed using Adobe Complete Suite (CS6) which consists of Adobe Fireworks, Adobe Flash Professional, User Interface, Adobe Audition and Adobe After Effect.

Enriched laboratory guide material (ELGM) experiment is the use of ELGM to conducting Basic Science experiments in schools where there are functional Biology, Chemistry and Physics laboratories. The ELGM contains activities which will enable the students to explore in order to discover relationship(s) between experimental variables in a physical laboratory. It minimizes potential equipment damage, time wasted, injury, and material wasted while maximizing potentials for generating usable data (National Council of Education Research and Training, NCERT, 2014; Pyatt and Sims, 2007). It could be produced as hard copies or delivered in electronic form (Hofstein and Lunetta, 2004). An ELGM was developed and validated to conducting experiments on reflection of light at a plane surface and relationship between potential difference and electric current in this study.

Research findings indicated that SL experiments as simulation mode of computer assisted/aided learning (CAL) could promote students' science process skills acquisition. Hughes (1973) reported that computer simulated experiments promoted level of attainment of science process skills by high school students in Physics. Lazarowitz and Huppert (2014) found that computer-assisted learning (CAL) software improved the mastery of tenth-grade students' science process skills in Microbiology. Yang and Heh (2007) observed enhanced posttest mean score in science process skills of tenth-grade students in internet virtual Physics laboratory (IVPL). Leonard (2006) reported the effectiveness of an interactive computer/videodisc learning package at improving students' level of acquisition of science process skills in Biology.

Studies revealed that the use of enriched laboratory guide material experiments had improved acquisition of science process skills. Feyzioğlu (2009) observed a significant positive linear relationship between level of acquisition of six science process skills by Turkish University students and efficient use of Chemistry laboratory. Jeenthong, Ruenwongsa and Sriwattanarotha (2013) found that laboratory experiments enhanced learning of integrated science process skills among high school students. However, Hirça (2013) reported no significant improvement in the level of acquisition of science process skills in hands-on laboratory experiments in Physics. Therefore, the literature reviewed reveal that most researches on the effectiveness of SL and ELGM were not conducted in Basic Science as they were performed among the senior secondary school, higher national diploma and university students. Hence, this study determined the effects of simulated laboratory and enriched laboratory guide material experiments on students' acquisition of science process skills in Basic Science.

The literature reviewed indicated no gender difference in the level of acquisition of some science process skills except observing skills among the tenth-grade students in Biology (Huppert, Lomask and Lazarowitz, 2010; Lazarowitz and Huppert, 2014). Therefore, there is need to exarmine level of acquisition of other science process skills by boys and girls in Basic Science. Although, Wyss, Heulskamp and Siebert (2012) found no gender difference in the Science, Technology and Mathematics Education (STEM) career choices of middle school students who were provided with STEM career information using video interviews of STEM professionals; Farenga and Joyce (1999) observed that many students between ages 9 and 13 supported female participation in life science courses and male participation in physical science courses. Also, future career interest determined later enrolment in science-related disciplines in New York. Thus, Biology and related courses could be used to promote acquisition of science process skills in females whereas physical sciences (Chemistry and Physics) and related courses could enhance development of the skills in males. Therefore, there is need to exarmine the future career interest in science and how it affects acquisition of science process skills in Basic Science.

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

- H_01: There is no significant main effect of treatment on students' acquisition of science process skills in Basic Science.
- H_02: There is no significant main effect of gender on students' acquisition of science process skills in Basic Science.
- H_03: There is no significant main effect of future career interest in science on students' acquisition of science process skills in Basic Science.
- H_04: There is no significant interaction effect of treatment and gender on students' acquisition of science process skills in Basic Science.

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H_05: There is no significant interaction effect of treatment and future career interest in science on students' acquisition of science process skills in Basic Science.

H_06: There is no significant interaction effect of gender and future career interest in science on students' acquisition of science process skills in Basic Science.

H_07: There is no significant interaction effect of treatment, gender and future career interest in science on students' acquisition of science process skills in Basic Science.

THEORETICAL FRAMEWORK

According to Kolb (1984:38), "Learning is the process whereby knowledge is created through the transformation of experience". Thus, ideas are not fixed but are usually sharpened or modified by experience until learning takes place. Kolb believes that the experience (information needed to bring about learning) could be obtained from either Concrete Experience (CE) or Abstract Conceptualization (AC) but not both simultaneously and that the experience could be processed through either Reflective Observation (RO) or Active Experimentation (AE) but not both at the same time. Thus, experience is translated through reflection into concepts (new ideas) which are used as guides for active experimentation (testing theories emanating from concepts or models of what have been observed) and choice of new experiences.

Kolb's experiential learning theory finds relevance in the present study in that experiential teaching is anchored on the belief that people learn from experience which is a function of practice or hands-on activities and sometimes the consequences of actions performed on physical objects. This is the basis of discovery learning found in the simulated and enriched laboratory guide material experiments. The use of simulated and enriched laboratory guide material experiments combined with learning together instructional strategy enables learners to create knowledge from taking turns to lead the conduct of the experiments and subsequent discussion, clarification and explanation of their performance in the group learning activities.

METHOD

The study adopted the pretest-posttest control group quasi-experimental design with a 3x2x2 factorial matrix to determine the effects of SL and ELGM experiments on junior secondary school students' achievement in Basic Science in Oyo State, Nigeria. Convenience sampling was used to select Ibadan (11 local government areas) and Oyo (four local government areas) from 33 local government areas in Oyo State, Nigeria. Three local government areas were randomly selected from each of Ibadan (Ibadan North, Ibadan South-East and Ibadan South-West) and Oyo (Afijio, Oyo-East and Oyo-West). Purposive sampling was used to select six co-educational public secondary schools based on availability of functional Computer and Physics laboratories. Six randomly selected intact classes of junior secondary three (JSIII) students consisting of 130 males and 147 females with an average age of 17 years were randomly assigned to SL (110), ELGM (60) and CEL (107) experiments. The junior secondary class three was used because Light and Electrical Energy had been planned for teaching under the theme "You and Energy" in Basic Science in the class by the Nigerian Educational Research and Development Council (NERDC) since 2006 and reiterated in 2012. All selected schools had not taught light and electrical energy at the junior secondary level. Experiments on reflection of light as well as relationship between potential difference and electric current were purposively selected for this study because a preliminary survey among Basic Science teachers in Oyo State have shown that light and electrical energy are among the perceived difficult topics of the NERDC Basic Science curriculum which are either not or poorly taught by the teachers.

Two response and three stimulus instruments were used in this study. Science process skills test in Basic Science (SPSTBS) was used to assess the level to which the students have acquired some science process skills during the conduct of Basic Science laboratory experiments. This instrument was adapted from Dillashav and Okey (1980) "A Test of the Integrated Science Process Skills for Secondary Science Students" with a reliability coefficient of 0.84 for the ninth-grade students in Boston. SPSTBS contains twenty-one multiple-choice items, each having four options: a, b, c, d. Each correct option is allotted one mark.

The instrument was designed to assess three basic science process skills (Classifying; Measuring; Predicting) and four integrated science process skills (Defining variables operationally; Identifying experimental variables; Presenting information - Organizing; Interpreting data - Describing relationships between variables) inherent in the conduct of the selected experiments. It consists of sections A and B. Section A was used to collect students' personal data. Section B contains 21 multiple-choice items, each having four options: a, b, c, d. Each correct option is allotted one mark.

The instrument was given to some lecturers in the Science education unit of the department of Teacher education, University of Ibadan, Ibadan and some practicing Basic Science teachers in order to establish its content validity, objectivity of its scoring key and clarity of its items. The instrument was administered to JSIII students who did not participate in the study. The reliability index of 0.72 was obtained using Kuder-Richardson formula 20 (KR-20).

Future career interest in science (FCIS) questionnaire was used to collect information on the type of profession / course of study students hope to go into after schooling. It consists of sections A and B. Section A contains students' personal data. Section B is a checklist of 38 (science-related=28 and non-science related=10) professions/courses of study, from which the learner indicated the preferred future career. The list was adapted from Osokoya (2003) Student Career Aspiration (SCA) and guided by the 2015/2016 eBronchure of the Joint Admissions and Matriculation Board (JAMB). Professions/courses of study which require that a candidate should possess the senior secondary certificate examination credit pass in at least one of Biology, Chemistry and Physics for admission into the university through JAMB were classified as science-related while those which do not require credit pass in any of such science subjects were grouped as non-science related. The instrument was given face-validity by experts in Science Education and it has a test-retest reliability index of 0.99 obtained by Cronbach's Alpha formula.

The stimulus instruments are instructional guide on simulated laboratory (IGSL), enriched laboratory guide material (IGELGM) and conventional (expository) laboratory (IGCEL) experiments. Each guide contains the procedure for conducting the respective experiments. The steps fall into six stages: introduction, discussion of basic concepts relevant to each experiment, demonstration of the experiment by the facilitator (teacher), group performance of the experiment by the students, deduction and verification of novel relationship(s) between experimental variables, and report writing. However, students in the CEL group were not required to deduce and verify relationship(s) between experimental variables. Treatments lasted seven weeks. The data collected were analysed using Analysis of covariance (ANCOVA) with the pretest scores as covariates to test the hypotheses at 0.05 level of significance. The Estimated Marginal Means (EMM) was computed to determine the posttest

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mean scores for different groups. Scheffé post-hoc analysis was used to determine the direction of significance.

RESULTS

H01: There is no significant main effect of treatment on students' acquisition of science process skills in Basic Science.

Table 1: Summary of ANCOVA of Posttest Science Process Skills' Acquisition Scores in Basic Science by Treatment, Future Career Interest in Science and Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model		12	44.686	8.471	.000	.278
Intercept	536.236[a]	1	9386.701	1779.366	.000	.871
Pre-Science Process Skills	9386.701	1	8.409	1.594	.208	.006
<u>Main Effect</u>	8.409					
Treatment		2	134.576	25.510	.000*	.162
Gender	269.151	1	9.008	1.708	.192	.006
Future Career Interest in	9.008					
Science		1	92.948	17.619	.000*	.063
<u>2-Way Interaction</u>	92.948					
Treatment x Gender		2	1.747	.331	.718	.003
Treatment x Future Career	3.494					
Interest in Science		2	2.276	.431	.650	.003
Gender x Future Career	4.552					
Interest in Science		1	.425	.081	.777	.000
<u>3-Way Interaction</u>	.425					
Treatment x Gender x						
Future Career Interest in		2	5.138	.974	.379	.007
Science	10.277	264	5.275			
Residual (Error)	1392.680	277				
Total	58627.000	276				
Corrected total	1928.917					

a. R Squared = .278 (Adjusted R Squared = .245) *Significant at $p<.05$

The results presented in Table 1 show that there was a significant main effect of treatment on students' acquisition of science process skills in Basic Science ($F_{(2,264)}=25.51$, $p<.05$; partial $\eta^2 = .162$). This implies that the treatment had significant main effect on students' posttest science process skills score in Basic Science, with an effect size of 16.2%. Therefore, hypothesis 1 is rejected. In order to determine the posttest mean scores of the groups, the estimated marginal means were computed and these are presented in Table 2.

Table 2: Estimated Marginal Means of Posttest Science Process Skills' Acquisition Scores in Basic Science by Treatment Groups

Group	N	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Treatment I(SL)	110	15.001[a]	.233	14.542	15.461
Treatment II(ELGM)	60	14.656[a]	.391	13.885	15.427
Treatment III(CONTROL/CEL)	107	12.591[a]	.256	12.087	13.094

a. Covariates appearing in the model are evaluated at Pre-Science Process Skills' Acquisition score=5.8700

Results from Table 2 reveal that the simulated laboratory experiment group obtained the highest posttest mean score (15.00) followed by the enriched laboratory guide experiment (14.66) and the conventional (expository) laboratory experiment group (12.59) respectively. This implies that students exposed to simulated laboratory experiment in Basic Science acquired more science process skills than those exposed to enriched laboratory guide material and conventional (expository) experiments. Furthermore, the sources of the significant effect of treatment on science process skills' acquisition in Basic Science were traced using Scheffé post-hoc test as shown in Table 3.

Table 3: Scheffé Post-Hoc Analysis of Treatment on Students' Science Process Skills' Acquisition in Basic Science

Group	N	Mean	SL	ELGM	CONTROL /CEL
1. Treatment I (SL)	110	15.001			*
2. Treatment II (ELGM)	60	14.656			*
3. Treatment III (CONTROL/CEL)	107	12.591	*	*	

*Pairs of Groups significantly different at p<.05

Scheffé post-hoc test on Table 3 shows that the posttest science process skills' acquisition mean score (15.00) of the SL group was significantly different from the mean score (12.59) of the CEL group. Also, the posttest science process skills' acquisition mean score (14.66) of students in the ELGM group was significantly higher than the mean score (12.59) of the CEL. Thus, the significant differences of the treatment on students' science process skills' acquisition exist between pairs of SL and CEL as well as ELGM and CEL. This implies that each of the SL and ELGM is significantly more effective in enhancing students' achievement in Basic Science than CEL.

H_{02}: There is no significant main effect of gender on students' acquisition of science process skills in Basic Science.

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Table 1 reveals that that there was no significant main effect of gender on students' acquisition of science process skills in Basic Science ($F_{(1,264)}$=1.71, $p<.05$). Therefore, hypothesis 2 is not rejected.

H03: There is no significant main effect of future career interest in science on students' acquisition of science process skills in Basic Science.

Table 1 shows that there was a significant main effect of future career interest in science on students' acquisition of science process skills in Basic Science ($F_{(1,264)}$=17.62, $p<.05$; partial η^2 =.063). This implies that the future career interest in science had a significant main effect on students' acquisition of science process skills posttest mean score in Basic Science, with an effect size of 6.3%. Therefore, hypothesis 3 is rejected. In order to determine how the groups performed, the Estimated Marginal Means were computed and these are presented in Table 4.

Table 4: Estimated Marginal Means of Posttest Science Process Skills' Acquisition Scores in Basic Science by Future Career Interest in Science Groups

Group	N	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1. Science-related	197	14.809[a]	.169	14.476	15.143
2. Non-Science related	80	13.356[a]	.302	12.762	13.951

a. Covariates appearing in the model were evaluated at Pre-Science Process Skills' Acquisition score= 5.8700

Table 4 reveals that students with science-related future career interest in science group had higher posttest science process skills acquisition mean score (14.81) in Basic Science than the non-science related group (13.36). This implies that students in the science-related future career interest in science group acquired more science process skills than those in the non-science related group.

H04: There is no significant interaction effect of treatment and gender on students' acquisition of science process skills in Basic Science.

Table 1 shows that there was no significant 2-way interaction effect of treatment and gender on students' acquisition of science process skills in Basic Science ($F_{(2,264)}$=.33, $p<.05$). Therefore, hypothesis 4 is not rejected.

H05: There is no significant interaction effect of treatment and future career interest in science on students' acquisition of science process skills in Basic Science.

Table 1 shows that there was no significant 2-way interaction effect of treatment and future career interest in science on students' acquisition of science process skills in Basic Science ($F_{(2,264)}$=.43, $p<.05$). Therefore, hypothesis 5 is not rejected.

H_{06}: There is no significant interaction effect of gender and future career interest in science on students' acquisition of science process skills in Basic Science.
Table 1 shows that there was no significant 2-way interaction effect of gender and future career interest in science on students' acquisition of science process skills in Basic Science ($F_{(1,264)}$=.08, p<.05). Therefore, hypothesis 6 is not rejected.

H_{07}: There is no significant interaction effect of treatment, gender and future career interest in science on students' acquisition of science process skills in Basic Science.
Table 1 shows that there was no significant 3-way interaction effect of treatment, gender and future career interest in science on students' acquisition of science process skills in Basic Science ($F_{(2,264)}$=.97, p<.05). Therefore, hypothesis 7(b) is not rejected.

DISCUSSION OF RESULTS

Effect of Treatment on Students' Acquisition of Science Process Skills in Basic Science

The results obtained in this study indicated that simulated laboratory and enriched laboratory guide material experiments had significant effect on students' acquisition of science process skills in Basic Science. The two modes of laboratory experiments enhanced students' acquisition of science process skills in Basic Science better than the conventional (expository) laboratory experiments. This is because students are well guided in the conduct of experiments through the procedure provided on the note field in the SL software and ELGM. Also, SL software is interactive such that correct operations are rewarded with the opportunity to continue to perform the experiment while students were unable to proceed with the experiment when incorrect operations were made on the software. Thus, the two modes of laboratory experiment engaged students more in inquiry-based activities which improved acquisition and retention of science process skills than the conventional (expository) laboratory experiments.

These findings are in agreement with the result obtained by Hughes (1973) report that computer-simulated experiment enhanced significantly the acquisition of science process skills in Physics by high school students than either the conventional laboratory experiments or a combination of both. Activity-oriented instruction type and mutual teacher physical interactions (Joju, 2003) which are the features of the simulated and enriched laboratory guide material experiments are not adequate in the conventional (expository) laboratory experiments. These improved acquisition of science process skills (Feyzioğlu, 2009) which are retained by the students for a longer time than the cognitive knowledge (Akinbobola and Afolabi, 2010).

Effect of Future Career Interest in Science on Students' Acquisition of Science Process Skills in Basic Science

The findings of this study showed that future career interest in science had significant effect on students' acquisition of science process skills in Basic Science. Science-related future career interest improved students' acquisition of science process skills in Basic Science more than non-science related future career interest in science. This is because anticipated/expected reward(s) in science-related future career (e.g. job prospects and job demands on science) aroused students' interest to participate in and learn science process skills in Basic Science (Wang and Staver, 2010; Njoku, 2003).

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CONCLUSION

This study revealed that simulated laboratory and enriched laboratory guide material experiments are effective at improving acquisition of science process skills of students in Basic Science notwithstanding the gender. Thus, simulated laboratory experiment offers a viable alternative to the use of hands-on laboratory experiment in order to teach Basic Science effectively especially in schools where there are no functional science laboratories. However, schools with well-equipped laboratory could enrich their practical lessons through the use of the enriched laboratory guide material experiments.

Future career interest in science could propel students to do well in science subjects. This is evident in greater acquisition of science process skills in Basic Science of students in the science-related than those in the non-science related future career interest. Thus, the relevance of students' future career interest to science and related discipline plays significant roles in the effective use of laboratory experiments to teach Basic Science practical.

The simulated laboratory and enriched laboratory guide material experiments are recommended for teaching the practical components of Basic Science in order to promote acquisition of science process skills in the subject. Relevant professional bodies like the across the world should organize seminars, workshops and conferences for practicing Basic Science teachers on the importance and use of simulated and enriched laboratory guide material experiments to teach the subject.

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