



Effect of Teacher-Learner Improvised Material on Critical Thinking Among Varied-Ability Upper Basic Science Students in Makurdi Metropolis

Geoffrey A. Ayua, Gabriel S. Ikyernum & Wisdom K. Terhamba

^{all}Department of Science and Mathematics Education, Benue State University, Makurdi, Nigeria

Corresponding Author: kwatexwisdom@gmail.com

Abstract

Effect of teacher-learner improvised material on critical thinking among varied-ability upper-Basic Science students in Makurdi was studied using quasi-experimental design. The study was guided by two research questions and two hypotheses. Out of 1337 Upper Basic II students in the 21 schools under Teaching Service Board-Makurdi, a multistage sample of 52 students was drawn. Critical Thinking Test with reliability coefficient of 0.76 determined using a test-retest method through Pearson Product Moment Correlation was used for data collection. Data were analysed using mean and ANCOVA. Findings showed no significant difference in the critical thinking level among varied-ability students taught Basic Science using Teacher-Learner Improvised Material and those taught using Teacher Improvised Material ($F_{(2, 45)} = 2.193; p = .123 > .05$). Although, there existed a significant difference in critical thinking level in favour of those taught using Teacher-Learner Improvised Material ($F_{(1, 45)} = 135.229; p = .000 < .05$), no significant difference existed in the students' critical thinking level based on gender ($F_{(2, 17)} = 2.09; p = .154 > .05$). Thus, teacher-learner improvisation approach was recommended for teaching science in basic schools.

Keywords: Teacher-Learner Improvised Material (TLIM), Teacher Improvised Material (TIM), Critical Thinking, Varied-Ability and Gender.

Introduction

One of the objectives of teaching Basic Science and Technology at Upper Basic school level is to enable the learners acquire knowledge and develop skills in science and technology; apply scientific and technological knowledge and skills to meeting contemporary societal needs (Federal Republic of Nigeria -FRN, 2014). This implies that science should develop students' critical thinking ability needed for survival in the cotemporary world. That could be why Samba, Achor, Bash and Iortim (2020) argued that, the challenges of the 21st century, with its complex environmental, social and economic pressures require young people to be creative, innovative, enterprising, and adaptable; exhibiting confidence and skills that enable them employ critical and creative thinking purposefully.

Critical thinking is regarded as the process of evaluating thoughts, evaluating arguments, dealing with problems or making judgments based on gathering and evaluating various information and opinions about specific standards to give the best solution (Shubina & Kulakli, 2019). Critical thinking is the one that considers, relates and evaluates all aspects of a situation or problem. This level of thinking includes skills such as focusing on elements of a problem or difficult situation; collecting and organizing information in the problem; remembering and incorporating the information learned. It can be

demonstrated that critical thinking is one of the crucial skills of thinking, requiring learners to be proactive in thinking about complicated problems or situations based on thoughts, views and beliefs (Ton, Loc, Uyen & Son, 2020). Developing critical thinking capacity is essential not only to help learners in their learning but also to create a premise for integration into society, thus meeting the needs of society (Mahanal, Zubaidah, Sumiati, Sari & Ismirawati, 2019).

The need for improvisation arises where there is lack of instructional materials. Over the years, it has been discovered that there is dearth in the availability of instructional materials in basic schools in Nigeria (Ayua 2021). In some cases, the available materials are either inadequate or obsolete, yet the teacher is expected by the Nigerian National Policy on Education to teach Basic Science at the basic education level experimentally (Federal Republic of Nigeria-{FRN}, 2014). With this, the teacher is forced to improvise to avoid entering the classroom to teach without teaching/learning materials.

Improvisation refers to selection or provision for something not readily available. It is the process by which educational materials can be designed and developed using locally available materials to meet specific instructional needs (Owuamanam, 2017). Science teaching requires standard equipment, chemicals and concrete resources for meaningful



teaching and learning. However, the poor funding of education coupled with increased students' population makes it difficult to acquire adequately the resources for practical demonstrations. Thus, the use of local materials in the teaching and learning of Basic science becomes imperative. This owes to the fact that teaching and learning of Basic Science requires effective utilization of instructional materials through hands-on activities since Basic science in its nature is an activity-based course (Agogo & Ode, 2017), hence the need for improvisation. Improvisation according to Ayua (2021) could be by substitution, modification and construction.

Teacher Improvised Material (TIM) refers to teaching aid(s) made by the teacher alone and brought to the classroom for Basic Science teaching. TIM is an improvisation approach that is teacher-based because learners are not involved in the process of producing the improvised instructional material(s) (Ayua, 2021). Studies have shown that Science teachers in middle-basic schools are quite aware of improvisation; yet their level of improvisation was low because they lacked basic practical skills and encouragement to improvise (Owuamanam, 2017; Ayua, 2021).

Teacher-Learner Improvised Material (TLIM) on the other hand means teaching aid(s) produced by the combined efforts of the teacher and the learners for Basic Science teaching and learning. This improvisation style is teacher-learner-based because both the teacher and the learners are actively involved in the process of improvising the teaching-learning material (s) (Ayua, 2021). Teacher-learner-based improvisation approach exposes learners to some basic content information and further exposes learners to experiences that could further develop their critical thinking potential before actual lessons. As a moderating coordinator in teacher-learner based improvisation, the teacher's experience and being proactive are key to saving the classroom from dearth of teaching/learning aids in order to enhance learners' level of critical thinking in Basic Science across varied-ability levels.

Varied-ability levels refer to students' high, average and low educational performance based on past academic scores in Basic Science. Maikano (2016) stated that students' ability level and gender determine grouping into homogeneous and heterogeneous schools/classes. Students' ability levels for the study were determined using previous term's academic performance. Placement into ability

levels was guided by Benue State Ministry of Education {BSME} (2021) and Benue State Examinations Board {BSEB} (2019) grading system for basic schools. Based on the grading system, High Ability Level (A = 75-100% and B = 65-74%), Average Ability Level (C = 55-64% and D = 45-54%) and Low Ability Level (E = 40-44% and F = 0-39%) were determined. Mahanal, Zubaidah, Sumiati, Sari and Ismirawati (2019) in their study established that there exists a significant difference in critical thinking between high and low ability students but were not concerned with average ability. Meanwhile, Avwiri (2017) found no significant difference in creativity among high, average and low ability learners without consideration to gender difference.

Gender difference is as old as the creation and has featured severally in academic discourse. It is the character of being male or female, man or woman, boy or girl. Gender disparity according to Danjuma (as cited in Ayua, 2021) globally militates against equitable participation of boys and girls in Science Education especially in Africa. This implies that gender peculiarities affect teaching, learning as well as critical thinking of pupils in Basic Science. Zhang, Ren and Deng (2020) in their study "gender differences in the creativity" found that a significant difference existed in creativity between males and females in favour of females. Likewise, Shubina and Kulakli (2019) found that females performed higher in critical thinking abilities than males. However, Ayua and Agbidye (2020) found no significant difference in level of entrepreneurial creativity between boys and girls taught Basic Science using Science-Technology-Society (STS). However, none of the studies were concerned with critical thinking as an aspect of creativity in relation to improvisation.

Improvisation and creativity are the two major concepts that promote effective production, selection and utilization of adequate instructional materials for effective teaching and learning of Basic Science especially in developing countries where the technology of production is still growing. Improvisation during teaching and learning has been introduced as a gate-way to enhancing creativity in learners (Navarro, 2018). Ton, Loc, Uyen and Son, (2020) in their study established that students' critical thinking skills were fostered as a result of their involvement in teaching-learning experiences. To this end a concerted effort needs to be made to see that teachers make use of the most appropriate instructional materials for specific learning situations.

Where the appropriate instructional materials are not available, the substitute should be provided through combined efforts of teachers and students. This should be done in such a manner that it inculcates and fosters critical thinking abilities in learners.

Though the need to expose students to experiences that will enhance their creativity through acquisition of knowledge and development of skills to make them become better fitted into the contemporary society has been emphasized (FRN, 2014), yet the creativity level of students has been observed to be low (Ensley, 2015; Avwiri, 2017). Improvisation during teaching and learning has been introduced as a gate to creative process (Ensley, 2015; Navarro, 2018). The need for improvisational activities in Basic Science has become a necessity as a result of the non-availability of instructional materials coupled with the fact that Basic Science teaching/learning requires effective utilization of instructional materials through hands-on activities since in its nature is an activity-based course (Agogo & Ode, 2017). Ayua and Jato (2012) lamented that the theoretical teaching of Basic Science makes it abstract, meaningless, boring, uninteresting, and difficult. Furthermore, Ayua (2021) found that Basic Science teachers' level of improvisation is low and, in most cases, do not involve the learner in the improvisation process. Though the importance of facilitating and promoting creativity development in the classroom by means of improvisation has been widely recognized through a good number of studies (Navarro, 2018; Ramon & Lopez, 2021) little attention has been paid to the issue of learners' critical thinking. It is against this background that "effect of Teacher-Learner Improvised Material on critical thinking among varied-ability Basic Science students" was studied with the following objectives:

1. To assess the mean difference in critical thinking level among high, average and low ability students taught Basic Science using Teacher Improvised Material and those taught using Teacher-Learner Improvised Material
2. To ascertain the mean difference in critical thinking level among high, average and low ability students taught Basic Science using Teacher-Learner Improvised Material based on gender

Based on the purpose of the study, the following research questions were posed:

1. What is the mean difference in critical thinking level among high, average and low ability students taught Basic Science using Teacher Improvised Material and those taught using Teacher-Learner Improvised Material?
2. What is the mean difference in critical thinking level among high, average and low ability students taught Basic Science using Teacher Learner Improvised Material based on gender?

Based on the purpose too, the following hypotheses were formulated

1. There is no significant difference in critical thinking level among high, average and low ability students taught Basic Science using Teacher Improvised Material and those taught using Teacher-Learner Improvised Material.
2. There is no significant difference in critical thinking level among high, average and low ability students taught Basic Science using Teacher-Learner Improvised Material based on gender.

Method

A pre-test post-test quasi-experimental-control group research design was used for the study. After pre-test administration, the experimental group was taught concept of work, energy and power using demonstration method blended with Teacher-Learner-Improvised Material (TLIM); while the control group was taught the same concept using same method but blended with Teacher-Improvised Material (TIM) for five weeks before post-test. A sample of 52 students in two schools drawn out of the 1337 (680 males and 657 females) Upper Basic II students in the 21 schools in Makurdi (TSB, 2021) was used for the study. The sample was drawn by multistage (including stratified, purposive and random) sampling. Critical Thinking Test (CTT) adapted from Kpiranyam (2021) was used for data collection. Students' ability levels were based on previous term's performance grades (high = A/B; average = C/D; low = E/F). CCT was validated and pilot tested using a test-retest method with Pearson Product Moment Correlation, which yielded a reliability coefficient of 0.76. Extraneous variables like group initial difference, group interaction effect and priming were



controlled by homogeneity test, distant locations and impromptu tests respectively. Both pre-test and post-test were administered under standard examination conditions. The research questions were answered using mean and standard deviation. The hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). These statistics were deemed suitable because independent (factor) variable(s) (TLIM and TIM) with two or more levels

(high, average and low ability); male and female gender of non-equivalent samples were covariate computed against the dependent (test) variable (critical thinking) which is interval scale and normally distributed.

Results

The results are presented as follows:

Table 1: Mean and Standard deviation of Critical Thinking Test Scores of students taught using Teacher Improvised Material and Teacher Learner Improvised Material.

Ability Level	N	Group	Pre-CTT		Post-CTT		Mean Gain	Mean Gain difference
			\bar{x}	SD	\bar{x}	SD		
High	12	TIM	14.67	4.376	18.50	3.205	3.83	6.42
	10	TLIM	18.50	2.563	28.75	2.121	10.25	
Average	8	TIM	11.50	5.099	14.00	4.000	2.50	10.36
	7	TLIM	13.71	1.380	26.57	2.760	12.86	
Low	8	TIM	9.00	3.703	11.50	5.632	2.50	13.21
	7	TLIM	10.00	4.619	25.71	2.430	15.71	
Cluster		TIM	11.72		14.67		2.94	10.00
		TLIM	14.07		27.01		12.94	

Results in Table 1 shows homogeneity in the pre-test mean scores among varied-ability levels between experimental and control group with cluster means of 14.07 and 11.72. The table also shows that all the

critical thinking level mean scores among the ability levels in the experimental group were higher than those in the control group with cluster mean gain difference of 10.00.

Table 2: Mean and Standard Deviation of Critical Thinking Test Scores of Students Taught Using Teacher Learner Improvised Material Based on Gender

Ability Level	Gender	N	Pre-CTT		Post-CTT		Mean Gain	Mean Gain Difference
			\bar{x}	SD	\bar{x}	SD		
High	Male	7	18.57	2.760	28.86	2.268	10.29	1.04
	Female	3	16.00	2.000	27.33	1.155	11.33	
Average	Male	2	13.00	1.414	26.00	2.828	13.00	0.20
	Female	5	14.00	1.414	26.80	3.033	12.80	
Low	Male	2	12.00	5.657	28.00	.000	16.00	0.40
	Female	5	9.20	4.604	24.80	2.280	15.60	
Cluster	Male		14.52		27.62		13.10	0.14
	Female		13.07		26.31		13.24	

Results in Table 2 shows homogeneity in the pretest mean scores between male and female in the experimental group with cluster means of 14.52 and 13.07. Likewise, the table also shows that the critical

thinking level mean scores in the posttest was also homogenous between male and female with cluster mean gains of 13.10 and 13.24 respectively.

Table 3: Summary of Two-way ANCOVA Results of Critical Thinking Test Scores of Students Based on Improvisation Technique

Source	Type III Sum of Squares	Df	Mean Square	F	p	Partial Eta Squared
--------	-------------------------	----	-------------	---	---	---------------------

Corrected Model	2136.851 ^a	6	356.142	29.999	.000	.800
Intercept	1275.579	1	1275.579	107.447	.000	.705
CTT pretest	32.317	1	32.317	2.722	.106	.057
Improvisation	1605.394	1	1605.394	135.229	.000	.750
Ability Level	72.079	2	36.040	3.036	.058	.119
Improvisation *Ability	52.079	2	26.039	2.193	.123	.089
Error	534.226	45	11.872			
Total	24936.000	52				
Corrected Total	2671.077	51				

a. R Squared = 0.800 (Adjusted R Squared = 0.773)

Table 3 showed that no significant difference in the critical thinking level among varied-ability students taught Basic Science using TIM and those taught using TLIM, $F_{(2, 45)} = 2.193$; $p = .123 > .05$. The null hypothesis was therefore not rejected. However, the result also showed that students' level of critical

thinking in the experimental group was better than those in the control group, $F_{(1, 45)} = 135.229$; $p = .000 < .05$. This thus implies that, although Teacher-Learner Improvised Material (TLIM) enhances critical thinking, it is not dependent on students' academic abilities.

Table 4: Summary of Two-way ANCOVA Results of-Critical Thinking Test Scores of Students Taught Using Teacher Learner Improvised Material Based on Gender

Source	Type III Sum of Squares	Df	Mean Square	F	P	Partial Eta Squared
Corrected Model	72.805 ^a	6	12.134	2.610	.056	.480
Intercept	900.717	1	900.717	193.755	.000	.919
CTT Pret1	20.095	1	20.095	4.323	.053	.203
Gender TLIM	14.616	1	14.616	3.144	.094	.156
Ability Level TLIM	33.126	2	16.563	3.563	.051	.295
Gender*Ability Level	19.431	2	9.715	2.090	.154	.197
Error	79.029	17	4.649			
Total	17756.000	24				
Corrected Total	151.833	23				

R Squared = .480 (Adjusted R Squared = .296)

Table 4 showed that no significant difference existed in the critical thinking level between male and female among varied-ability Basic Science students taught using Teacher Learner Improvised Material, $F_{(2, 17)} = 2.09$; $p = .154 > .05$. The null hypothesis was therefore not rejected. This thus implied that, Teacher Learner Improvised Material is gender unbiased; hence it enhanced critical thinking level in both male and female varied-ability Basic Science students.

Discussion

Concerning students' critical thinking level based on their involvement in the improvisation of instructional materials, it was found that significant difference existed in the critical thinking level between students in the control and experimental group in favour of those in the experimental group. However, among the ability levels there existed no significant difference in the critical thinking level. Following field experience, the finding of this study

is not odd because in the experimental group, students' innate critical thinking abilities were ticked during the construction process through exposure to experiences that would boost their constructive reasoning, interpretation, analysis, deduction and evaluation of arguments. Also, students could easily relate the experiences during the construction process to the concept being taught and could now correlate their experience with everyday life and hence apply their critical thinking abilities to solve problems. This finding is in agreement with that of Ton, Loc, Uyen and Son (2020) who also found out that there was a significant increase in students critical thinking abilities as a result of their involvement in teaching learning activities. The indifference among the varied-ability in critical thinking as found out is similar to Avwiri's (2017) findings of no significant difference in creativity among varied ability students. However, the finding is not only different but also a



solution to the finding of Mahanal, Zubaidah, Sumaita, Sari and Ismirawati (2019) who found that there was a significant difference between high ability and low ability students in critical thinking.

Concerning students' critical thinking level based on gender, it was discovered that no significant difference existed in critical thinking level between male and female varied-ability Basic Science students taught using Teacher-Learner Improvised Material. Thus, involving students in the improvisation of instructional materials to enhance their critical thinking level is gender unbiased. Following field experience, the finding is not strange because both boys and girls were excited, thoughtful and actively involved in the teacher-learner improvisation as well as the teaching-learning processes. This finding is similar to that of Ayua and Agbideye (2020) of no significant difference in level of entrepreneurial creativity between boys and girls taught Basic Science using Science-Technology-Society (STS). The finding however, contradicts those of Zhang, Ren and Deng (2020) who found a significant difference in creativity based on gender in favour of females and Shubina and Kulakli (2019) who established that females scored higher than males in high level critical thinking tests and thus possessed higher critical thinking abilities than males.

Conclusion and Recommendations

Based on the findings, it was concluded that: The level of creative thinking among varied ability students can be enhanced without gender disparity if learners are actively involved in the improvisation of instructional materials. To do this effectively, the following were recommended:

1. Teachers should actively involve learners in the improvisation of instructional materials.
2. Ministries of Education at the LGEA level and teacher training institutions in Nigeria should ensure in-service training and retraining of teachers on Teacher-Learner Improvisation
3. School proprietors, head and parents' teachers' association (PTA) should materially/financially support Teacher-Learner Improvisation in Basic Science.
4. School administrators should encourage researchers to organize workshops on the use of Teacher-Learner Improvisation.

References

- Agogo, P.O. & Ode, J.O. (2017). *Issues in Integrated Science Curriculum*. Makurdi: Optimum Press.
- Avwiri, E. (2017). Creativity of secondary school students: entrepreneurial skills acquisition in the construction of potentiometer in physics. *International Journal of Science and Technology (STECH)* Vol 6 (2) 61-75.
- Ayua, G. A. & Jato, N. I. (2012). Enhancing the teaching and learning of basic science in Nigeria through exploration of resources in the environment. *Benue State University Journal of Education*, 12, 96-103.
- Ayua, G. A. & Agbideye, A. (2020). Effect of science-technology-society strategy on entrepreneurial creativity among upper-basic school students. *Journal of Science Technology and Education*, 4(9), 105-113.
- Ayua, G. A. (2021). Impact of teacher-learner improvised material on performance in Basic Science among mixed-ability middle-basic school pupils. *Benue State University Journal of Science, Mathematics and Computer Education*, 2(1), 105-114.
- Benue State Examination Board – BSEB. (2019). *Basic education certificate examination's grading system*. Makurdi, Nigeria: BSEB Office.
- Benue State Ministry of Education – BSME, (2021). *Examination grading system*. Makurdi, Nigeria: BSME Office.
- Benue State Teaching Service Board (2021). *Population of students in Makurdi Local Government Area of Benue State*. Department of records and statistics, Makurdi.
- Ensley, C. M. (2015). *The Creative Commodity: A Study of Improvisation in Middle and High School Choral Classrooms in Florida*. Selected Honours Theses, Paper 51.
- FRN. (2014). *National Policy on Education*. Nigeria: FGN Press.
- Kpiranyam, F. S. (2021). *Effects of student team achievement division (STAD) and assertive questioning instructional strategies (AQIS) on students' critical thinking and performance in Biology in Benue State, Nigeria*. Unpublished dissertation, Department of science and mathematics



- education, Benue state university, Makurdi-Nigeria
- Mahanal, S. Zubaidah, J. M., Sumiati, I. D., Sari, T. M. & Ismirawati, N. (2019). RICOSRE: A learning model to develop critical thinking skills for students with different academic abilities. *International Journal of Instruction*, Vol.12, No.2, 417-434.
- Maikano, S. (2016). *Impact of computer-assisted and science process instructions on retention and performance in biology among varied abilities secondary school students in Kaduna, Nigeria*. PhD Science Education thesis, Ahmadu Bello University, Zaria, Kaduna State.
- Navarro, L. (2018). *An assessment model to review musical patterns for improvisation: A questionnaire to evaluate creative processes in music education*. In T. Brophy, & M. Fautley (Eds.), *Context matters. Selected papers from the sixth International symposium on assessment in music education* (pp. 235-251). Chicago, IL: GIA Publications Inc.
- Onwuamanam, C. N (2017). Creativity in the improvisation and utilization of instructional materials for the Nigerian school system. *International Journal of Public Policy and Administrative Studies*, 11(3), 48-59.
- Ramon, L. N. & Lopez, H. C. (2021). The impact of musical improvisation on children's creative thinking. *Thinking Skills and Creativity Journal*. 40 (2021) 100539.
- Samba, R.M.O., Achor, E. E., Bash, A. E. & Iortim, S. O. (2020). Fostering students' critical thinking and achievement in basic science using graphic organizer and experimental learning strategies with feedback. *Science Education International*, 31(2), 202-225.
- Shubina, I & Kulakli, A. (2019). Critical thinking, creativity and gender differences for knowledge generation in education. *Literacy Information and Computer Education Journal (LICEJ)*, 10, (1).
- Tong, D H., Loc, N. P., Uyen, B. P., & Son, T. H. (2020). Enhancing creative and critical thinking skills of students in Mathematics classrooms: An experimental study of teaching the inequality in high schools. *Universal Journal of Educational Research* 8(2): 477-489.
- Zhang, ., Ren, P. & Deng, L. (2020). Gender differences in the creativity-academic achievement relationship: A Study from China. *The Journal of Creative Behaviour*, 54 (3).