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EFFECT OF INTEGRATED INQUIRY-BASED SCIENCE TEACHING STRATEGY ON BASIC EDUCATION STUDENTS' BELIEFS IN TARABA STATE, NIGERIA

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ABSTRACT

In an attempt to improve students' learning of basic science, this study examined the effect of Integrated Inquiry-Based Science Teaching strategy on Basic Education Students' Beliefs in Basic Science. Three objectives, research questions and hypotheses guided the study. Quasi-experimental research design was used for the study. Out of 4,141 basic education students 292 Basic Education students were sampled for the study. Data was generated using Basic Science Student Belief Inventory (BSSBI). Using Cronbach's Alfa Coefficient BSSBI reliability coefficient was found to be 0.90. Mean and standard deviation was used to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Result of the study showed among others that there was significant difference in the mean belief scores of students taught Basic science using Integrated Inquiry-Based Science teaching strategy and those taught using guided Inquiry Instructional Strategy, it was concluded that the strategy enhanced students' academic beliefs in Basic science. One of the recommendations is that *basic science teachers should be encourage to use Integrated Inquiry-Based Science Teaching strategy***.**

Keywords: Integrated Inquiry-Based, Science Teacher, Science Teaching Strategy, Basic Education, Beliefs.

INTRODUCTION

Basic science is the science concept designed to expose learners to scientific and technological knowledge and skills that will assist them to make informed decisions, develop strategies and learn to contribute meaningfully in the contemporary society (Ellah & Achor, 2017). This implies that acquisition of adequate knowledge in the subject could equip the learner with what it takes to become useful to the society and also to be prepared for further studies in science thus fulfilling, the National goals of Education in Nigeria (NPN, 2014). On the same note, Ayodele (2016) submitted that Basic Science is the bedrock of future understanding of advanced studies in Science, Technology and Engineering. This shows that the concept if well-captured could prepare the learner for further studies in science at the secondary school level of Education as insinuated by Oludipe (2012). This submission implies that the subject is the foundation of science education in Nigeria

Despite this importance of basic science to life, students perform poorly in Basic Science as documented in the Education Resource centre of Taraba State Ministry of Basic and Secondary Education report of BECE results for Basic Science and Technology (BST) from 2013-2022. Statistics of results revealed poor performance by students in Basic Science. From the analysis, it is clear that there is a trend of poor performance as performance was inconsistent and score per year range. There is no appreciable improvement in academic performance of students in Basic Science in BECE between the years 2013 – 2022. This could be attributed to the type of instructional strategy employed for lesson delivery.

Instructional strategy is the various methods used by the teacher in order to achieve the set objectives of the lesson. There are so many of such strategies amongst which is integrated inquiry-based science teaching strategy. Inquiry as submitted by Danjuma (2015) is an approach to learning that involves a process of exploring the natural or material world, and that leads to asking questions, making discoveries, and testing those discoveries in the search for new understanding.. The types of inquiry-based learning as clearly outlined by Yoon, Joung and Kim (2012) as cited Ali (2014) are:

Confirmation inquiry, structured inquiry, guided inquiry, open/true Inquiry and integrated inquiry-based strategy.

Warner and Myers (2014) submitted that Integrated inquiry-based science teaching strategy is a student-centered pedagogical approach that leverages the interconnections across different areas of science and focuses on cultivating critical thinking and problem-solving skills in students through active investigations. Some key components and Teaching Strategy include:

1. feedback integrated inquiry- based Teaching Strategy: Effective use of feedback integrated inquiry-based Teaching Strategy involves the learners in teaching and learning processes. it is the process which teachers and students provide response during instruction to organize the learning process for attainment of stated objectives.
2. Integration across domains: The curriculum and learning activities incorporate linkages across domains like physical, life, earth sciences rather than teaching them separately. Students learn to apply concepts across disciplines.
3. Student-directed exploration: Learners are able to frame research questions, design experiments, collect observation data, analyze results and draw evidence-based conclusions with appropriate scaffolding. Activities develop lab, analytical and questioning abilities.
4. Hands-on investigations: Students conduct practical and interactive investigations through lab work, field studies, controlled tests, simulations etc. manipulating variables and witnessing concepts first-hand through repeated trials.
5. Critical analysis: Learners are taught to synthesize findings, critique methodologies, assess sources, argue using evidence, identify knowledge gaps and formulate further questions to continue inquiry. Develops analytical skills.
6. Collaborative work: Group discussions, team-based projects, interactive presentations and peer learning tasks enable perspective sharing and allow students to build on each other's ideas under teacher guidance.

Integrated Inquiry-Based Teaching Strategy is a hybrid of two or more types of inquiry-based learning. Integrated-inquiry-based learning involves developing questions, making observations, doing research to find out what information is already recorded, developing methods for experiments, developing instruments for data collection, collecting, analyzing, and interpreting data, outlining possible explanations and creating predictions for future study. The teachers' role is that of modifying students' responses. Integrated inquiry-based instructional strategy addresses the context of basic science from multiple subject area.

Putnam and Wilcox (2020) define guided inquiry instructional strategy as "a teaching strategy that combines teacher guidance with student-centred learning experiences that promote inquiry, critical thinking, and problem-solving skills." They emphasize the importance of guided inquiry as a powerful instructional strategy that engages students in the learning process, fosters their curiosity, and promotes the development of essential skills for success in the 21st century. By allowing students to explore concepts and ideas through inquiry-based activities while providing appropriate guidance and support, teachers can cultivate a learning environment that encourages active participation, critical thinking, and self-directed learning.

Padilla and Brill (2021) define guided inquiry instructional strategy as "a student-centered instructional strategy in which the teacher facilitates the learning process by providing guidance and support to students as they explore concepts, formulate questions, and investigate solutions through inquiry-based activities." They highlight the importance of guided inquiry as a powerful instructional strategy that promotes active learning, fosters scientific literacy, and develops essential skills for scientific inquiry. By engaging in guided inquiry activities, students not only learn content knowledge but also develop critical thinking, problem-solving, and communication skills that are essential for success in the 21st century.

Both authors emphasize the importance of guided inquiry in promoting student-centered learning, developing critical thinking and problem-solving skills, fostering inquiry-based learning, and

cultivating essential skills for success in the 21st century. The guidance provided by the teacher is crucial in scaffolding the learning process and supporting students as they explore concepts and investigate solutions.
There is a close relationship between integrated inquiry-based science teaching strategy and guided inquiry instructional strategy. Both approaches share a common goal of actively engaging students in the learning process through inquiry-based activities and fostering the development of critical thinking, problem-solving, and investigative skills.

Karaman & Karaman 2013 submitted that belief is an acceptance that something exists, especially one without proof. Also, that scientific belief is a belief that the method natural science or the categories and things recognized in natural science, from the only proper element and any philosophical or other inquiry. Individuals' beliefs about science Teaching Strategy are psychological understandings, premises or propositions about science teaching that have sufficient validity to guide their thoughts and behaviors (Tondeur, & Ottenbreit-Leftwich, 2016). The fact that two students with similar knowledge about science learn in different ways suggest that students come to basic science class with different beliefs. Understanding students' beliefs is important to recognize and predict their intellect decisions in basic science classes because of the following reasons as stipulated by Bryan (2012): (i) individuals' beliefs about science Teaching Strategy are relatively stable and resistant to change, (ii) they have strong affective and evaluative components, (iii) they are deeply personal, (iv) they do not require universal or group consensus to validate and determine their relevance and exist in the individuals' episodic memories. Learners hold a continuum of beliefs about science Teaching Strategy with some being core and others being peripheral. They hold several components of beliefs about science Teaching Strategy in their belief systems. These include beliefs about "characteristics of science teachers and the learning environment", "how students learn science", "nature of science curriculum", and "science lesson design and implementation" (Karaman & Karaman, 2013; Sampson, Enderle, & Grooms, 2013). By these submissions the authors could be insinuating that beliefs are of different categories.

Students' beliefs can broadly be categorized as traditional (behaviourist) or constructivist (inquiry) in nature (Tondeur, Braak, Ertmer & Ottenbreit-Leftwich, 2016). Teachers and students with traditional beliefs about science Teaching Strategy consider science curriculum as a list of facts that must be presented and learned through rigid teaching approaches such as conventional teaching method. They engage in traditional classroom interactions in which teachers ask series of close-ended questions for students to answer and employ lecture and "chalk-and-talk" methods to impart knowledge to students (Karaman & Karaman, 2013; Mansour, 2013; Sampson, Enderle, & Grooms, 2013; Tondeur, & Ottenbreit-Leftwich, 2016). By so doing, they engage in summative assessment of learning to determine whether transmission of scientific knowledge was successful or not.

In contrast, to teachers and students with behaviorist beliefs, teachers and students with constructivist beliefs about science teaching and learning, value active participation inculcating and constructing knowledge. They consider science learning as Teaching Strategys where students gradually expand their networks of ideas through interaction with their peers and materials in the environment (Karaman & Karaman, 2013; Mansour, 2013; Sampson, Enderle, & Grooms, 2013; Tondeur, & Ottenbreit-Leftwich, 2016). They consider science learning as inquiry into students' generated questions and a process that can proceed in various directions away from the original plans (Kazempour, 2014). Teachers with inquiry-based beliefs provide opportunities and support for students to reflect as they develop conceptual understandings and learn more about scientific inquiry through developed positive attitudinal disposition (Mansour, 2013). These could enable student to develop scientific belief in learning.

Purpose of the Study

The purpose of this study was to investigate the effect of integrated inquiry-based science Teaching Strategy on students' beliefs in Basic Science in Taraba State, Nigeria. Specifically, the study found out:

1. The effect of integrated-inquiry-based science teaching strategy and guided inquiry teaching strategy on basic education students' beliefs in basic science.
2. The effect of using integrated-inquiry-based science teaching strategy and guided inquiry teaching strategy on male and female students' beliefs in Basic Science.
3. Determine the interaction effect of gender and instructional strategy on students' beliefs in Basic Science.

Research Questions

1. What is the mean belief rating of students taught basic science using integrated inquiry-based science teaching strategy and those taught using guided inquiry teaching strategy?
2. What is the mean belief rating of male and female students taught basic science using integrated inquiry-based science teaching strategy?
3. What is the interaction effect of gender and instructional strategies on students' beliefs in Basic Science?

Hypotheses

The following hypotheses were formulated to be tested at 0.05 level of significance

1. There is no significant difference in the mean belief scores of students taught Basic Science using integrated-inquiry-based science teaching strategy and those taught using guided inquiry teaching strategy.
2. There is no significant difference in the mean belief score of male and female students taught Basic Science using integrated-inquiry-based science teaching strategy
3. There is no significant interaction effect of gender and instructional strategy on students' belief in basic science

METHODOLOGY

The research design that was adopted for the study was quasi-experimental design. Pre-test, posttest and non-equivalent groups. This was because randomization was not possible as intact classes were used. The study was conducted in Jalingo Education Zone of Taraba State, Nigeria. Jalingo Education Zone is made up of three local governments namely; Ardo-kola local Government, Jalingo Local Government and Lau local Government. The choice of Jalingo Education Zone was based on the sampling procedure.

The population of the study consisted of all the 4,141 upper basic II Students from the 50 Schools in Jalingo education zone of Taraba State 2023/2024 academic session, Taraba State Ministry of Education, Post Primary School Management Board. The population of Upper Basic II Students which consisted of 2,338 males and 1,803 females' students.

The sample of the study comprised of 292 Upper Basic Education Two students from Jalingo Education Zone. Which was made up of 139 male students and 153 female students randomly drawn from 6 intact classes which constituted the sample for the study. The multi-stage random sampling techniques were used in constituting the sample for the study. Multistage sampling is an extension of cluster sampling in that, first, clusters are randomly selected and, second, sample units within the selected clusters are randomly selected. In this design, random selection occurs at both the cluster or group level and at the sample unit level.

The instruments that used for the study was adapted and organized by the researcher, named Basic Students Scientific Belief Inventory (BSSBI),

The reliability index obtained was 0.90 for BSSBI. Cronbach alpha was used to establish the reliability index of BSSBI. The index above reveals that the instrument is highly reliable for the study

Mean and Standard Deviation was employed to answer the research questions 1-3, while Analysis of Covariance (ANCOVA) was used to test the null hypotheses 1-3 at 0.05 level of significance.

RESULTS

Research Question One.

What is the mean belief rating of students taught basic science using integrated inquiry-based science teaching strategy and those taught using guided inquiry teaching strategy?

Table 1: Mean Belief Rating of Students taught Basic Science using Integrated Inquiry-Based Science Teaching Strategy and Guided Inquiry Instructional Strategies

Strategies		PreBSSBI	PostBSSBI	Mean Gain
Integrated Inquiry-Based Science Teaching Strategy	Mean	2.58	3.18	0.60
	N	138	138	
	Std. Deviation	1.05	0.49	
Guided inquiry instructional strategy	Mean	2.28	2.93	0.11
	N	154	154	
	Std. Deviation	0.97	0.80	
Mean difference				0.49

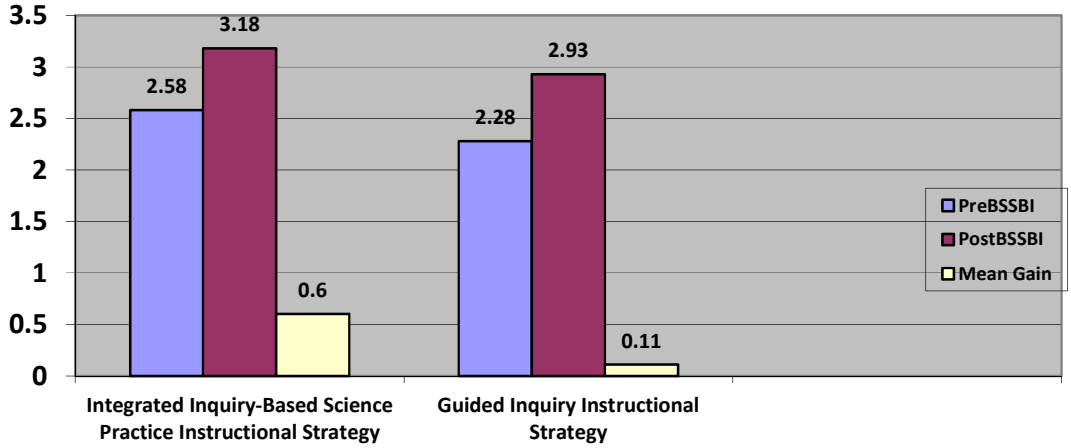

Figure 1: Pretest, Posttest Mean Gain in Belief Rating of Students taught Basic Science using Integrated Inquiry-Based Science Teaching Strategy and Guided Inquiry Instructional Strategies.

Table 1 shows the mean belief rating of students taught basic science using integrated inquiry-based science teaching strategy and guided inquiry teaching strategy. The table shows that 138 students were taught basic science using integrated inquiry-based science teaching strategy and 154 students were taught basic science using guided inquiry instructional strategy. The table reveals that the mean belief rating of students taught basic science using integrated inquiry-based science Teaching Strategy instructional strategy is 2.58 with a standard deviation of 1.05 during pre-test and 3.18 with a standard deviation of 0.49 in post test while the mean belief rating of students taught basic science using guided inquiry instructional strategy is 2.28 with a standard deviation of 0.97 during pre-test and 2.93 with a standard deviation of 0.80 in post test. The table further shows that the mean gain for integrated inquiry-based science Teaching Strategy instructional strategy is 0.60 and guided inquiry instructional strategyis 0.11. The difference in the mean belief rating of

students taught basic science using integrated inquiry-based science Teaching Strategy instructional strategy 0.49 in favour of students in integrated inquiry-based science Teaching Strategy class.

Research Question Two.
What is the mean belief rating of male and female students taught basic science using integrated inquiry-based science Teaching Strategy?

Table 2: Mean Belief Rating of Male and Female Students taught Basic Science using Integrated Inquiry-Based Science Teaching Strategy

Gender		PreBSSBI	PostBSSBI	Mean Gain
	Mean	2.46	3.19	0.73
Male	N	65	65	
	Std. Deviation	1.09	0.48	
	Mean	2.63	3.18	0.55
Female	N	73	73	
	Std. Deviation	1.04	0.52	
Mean difference				0.18

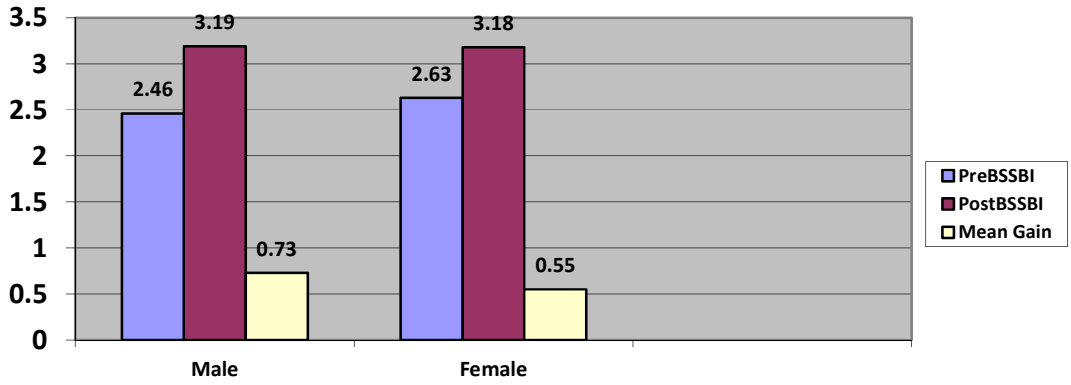

Figure 2: Pretest, Posttest Mean Gain in Belief Rating of Male and Female Students taught Basic Science using Integrated Inquiry-Based Science teaching strategy.

Table 2 shows the mean belief rating of male and female students taught basic science using integrated inquiry-based science Teaching Strategy. The table shows that 65 male students and 73 female students were taught basic science using integrated inquiry-based science Teaching Strategy instructional strategy. The table reveals that the mean belief rating of male student taught basic science using integrated inquiry-based science Teaching Strategy is 2.46 with a standard deviation of 1.09 during pre-test and 3.19 with a standard deviation of 0.48 in post test while the mean belief rating of female student taught basic science using integrated inquiry-based science Teaching Strategy is 2.63 with a standard deviation of 1.04 during pre-test and 3.18 with a standard deviation of 0.52 in post test. The table further shows that the mean gain for male students is 0.73 and female students is 0.55. The difference in the mean belief rating of male and female students taught basic science using integrated inquiry-based science Teaching Strategy is 0.18 in favour of male students in integrated inquiry-based science Teaching Strategy class.

Research Question Three.
What is the interaction effect of gender and instructional strategies on students' beliefs in Basic Science?

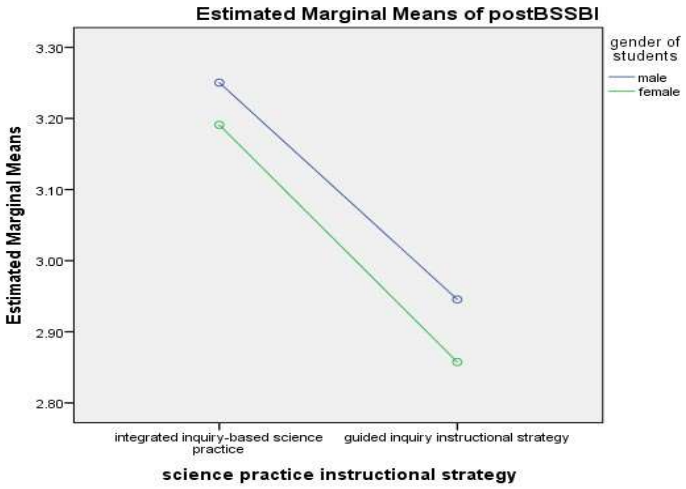

Figure 3: Interaction Effect of Gender and Instructional Strategies on Students' Beliefs in Basic Science

In Figure 3, the profile plot shows the interaction effect of gender and instructional strategies on students' beliefs in Basic Science. The interaction pattern shows that the plots for male and female do not intersect at the integrated inquiry-based science Teaching Strategy. The interaction pattern further shows that the plot for male and female do not intersect at guided inquiry instructional strategy. The plots for male and female is parallel lines, this indicates that there is no likelihood of an interaction effect of strategies and gender when the plot is extrapolated.

Hypothesis One: There is no significant difference in the mean beliefs scores of students taught Basic Science using integrated-inquiry-based science teaching strategy and those taught using guided inquiry strategy.

Table 3: ANCOVA of Belief Score of students when taught Basic Science using Integrated-Inquiry-Based Science Teaching strategy and Guided Inquiry teaching Strategy

Dependent Variable: postBSSBI

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	27.482[a]	2	13.741	36.223	.000	.200
Intercept	191.772	1	191.772	505.533	.000	.636
Belief	23.073	1	23.073	60.822	.000	.174
Strategies	7.039	1	7.039	18.555	.000	.060
Error	109.631	289	.379			
Total	2862.296	292				
Corrected Total	137.113	291				

a. R Squared = .200 (Adjusted R Squared = .195)

Table 3 reveals that F (1,289) = 18.555; p = 0.000 < 0.05. Thus, the null hypothesis is rejected. This implies that there is significant difference in the mean beliefs scores of students taught Basic Science using integrated-inquiry-based science teacher Teaching Strategy and those taught using guided inquiry instructional strategy. Thus, there is significant difference in the effect of integrated-inquiry-based science teacher Teaching Strategy and guided inquiry instructional strategy on mean beliefs scores of students in Basic Science. The partial Eta square of 0.060 obtain for strategies means that only 0.6 percent of students' mean beliefs in Basic Science can be attributed to the strategies employed.

Hypothesis Two: There is no significant difference in the mean belief score of male and female students taught Basic Science using integrated-inquiry-based science teaching strategy and those taught using guided inquiry instructional strategy.

Table 4: ANCOVA of Belief Score of Male and Female Students taught Basic Science using Integrated-Inquiry-Based Science Teaching Strategy

Dependent Variable: postBSSBI

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2.501[a]	2	1.250	5.455	.005	.078
Intercept	158.337	1	158.337	690.831	.000	.843
preBSSBI	2.494	1	2.494	10.880	.001	.078
Gender	.043	1	.043	.188	.665	.001
Error	29.567	135	.229			
Total	1374.738	138				
Corrected Total	32.067	137				

a. R Squared = .078 (Adjusted R Squared = .064)

Table 4 reveals that F (1,135) = 0.188; p = 0.665 > 0.05. Thus, the null hypothesis is not rejected. This implies that there is no significant difference in the mean belief score of male and female students taught Basic Science using integrated-inquiry-based science teachers Teaching Strategy. Therefore, there is no significant difference in the effect of integrated-inquiry-based science teacher Teaching Strategy on mean belief score of male and female students in Basic Science. The partial Eta square of 0.001 obtain for gender means that only 0.1 percent of students' mean belief in Basic Science can be attributed to gender.

Hypothesis Three

There is no significant interaction effect of gender and instructional strategy on students' belief in basic science. Data testing this hypothesis are contained in Table 5.

Table 5: ANCOVA of Interaction Effect of Gender and Instructional Strategies on Students' Belief in Basic Science

Dependent Variable: postBSSBI

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	27.896[a]	4	6.974	18.326	.000	.203
Intercept	190.937	1	190.937	501.740	.000	.636
Belief	22.338	1	22.338	58.701	.000	.170
Strategies	7.264	1	7.264	19.088	.000	.062
Gender	.392	1	.392	1.029	.311	.004
strategies * gender	.015	1	.015	.039	.844	.000
Error	109.218	287	.381			
Total	2862.296	292				
Corrected Total	137.113	291				

a. R Squared = .203 (Adjusted R Squared = .192)

Table 5 reveals that F (1,187) = 0.039; p = 0.844 > 0.05. Thus, the null hypothesis is not rejected. This implies that there is no significant interaction effect of gender and instructional strategies on students' belief in basic science. Therefore, there is no significant interaction effect of instructional strategies and gender on students' belief in basic science. The partial Eta square of 0.000 obtain for strategies and gender shows no interaction effect of strategies and gender.

DISCUSSION

Finding revealed that the mean belief ratings of students taught basic science using integrated inquiry-based science Teaching Strategy instructional strategy was higher than those taught using guided inquiry instructional strategy. There is significant difference in the mean beliefs scores of students taught Basic Science using integrated-inquiry-based science teacher Teaching Strategy and those taught using guided inquiry instructional strategy. This implies that significant difference exists in the effect of integrated-inquiry-based science teacher Teaching Strategy and guided inquiry instructional strategy on the mean beliefs scores of students in Basic Science. The finding agrees with Mohammed (2022) that there are significant school type and academic qualification differences in teachers' beliefs about inquiry-based science teaching. The finding also agrees with Blazar and Kraft (2017) that upper-elementary teachers have large effects on self-reported measures of students' self-efficacy in Mathematics and happiness and behaviour in class.

Finding revealed that the mean belief rating of male students taught basic science using integrated inquiry-based science Teaching Strategy was higher than that of female students taught basic science using integrated inquiry-based science Teaching Strategy. There was no significant difference in the mean belief score of male and female students taught Basic Science using integrated-inquiry-based science teachers Teaching Strategy. This implies that the use of integrated-inquiry-based science Teaching Strategy is gender friendly with reference to the mean belief score of male and female students in Basic Science. However, the finding disagrees with Schwab, Markus and Hassani (2022) that significant effects were found for gender and students with migration biography.

The present study attributed the causes of the non-significant interaction effect of strategies and gender on students' beliefs, interest and academic performance to the non-sensitive nature of the instructional strategies to gender. The reason to a large extent is that the male and female students in their inquiry groups are practically and meaningfully involved and engaged from planning stage to the evaluative stage of the enquiry process. The natural process the learners follow when seeking answers and deeper understanding closely follows the generally accepted scientific method. The curiosity of students is there combines with scientific method to enhance beliefs, the development of positive interest and improve academic accomplishment while learning science.

CONCLUSION

Based on the findings of the study it was concluded that:

i. The use of integrated inquiry-based science teaching strategy enhance students' academic beliefs in Basic science.
ii. Both gender are capable of competing and participating in classroom activities benefits effective when exposed to appropriate teaching and learning strategies.

RECOMMENDATIONS

i. Basic Science Teachers should be encouraged to use integrated inquiry-based science teacher Teaching Strategy.
ii. Basic science teacher trainees should be trained on the use of this teaching strategy which could improve academic performance of Basic Education student.
iii. Curriculum planners and science teachers should incorporate innovative, problem solving and activity based pedagogical strategies like inquiry based teaching strategy in all teacher education instructions.

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