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Level of awareness and utilization of innovative methods for teaching-learning physics and mathematics in Rivers state

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Abstract

Innovative teaching methods (ITMs) are methods other than the traditional talk-chalk methods. This study evaluated the extent to which senior secondary school physics and mathematics teachers are aware and utilize ITMs in Ahoada - East local government area (AELGA), and Ogba/Egbema/Ndoni local government area, Rivers State. The study sample was seventy (70) teachers, comprising 40 from public school and 30 from private schools in AELGA and ONELGA. A 4-point structured questionnaire was used as instrument for data collection. The reliability of the questionnaire tested with Pearson correlation moment coefficient of 0.87, and was considered reliable for the study. The study answered three research questions. Data was analyzed using frequency, descriptive statistics and paired sample t-test at 5% level of significance. The result showed that the teachers were aware of some of ITMs to a lesser extent but rarely used them in subject delivery. Level of awareness and utilization by both groups of teachers were not significantly different (p>.05), both in public and private schools and LGAs. It was recommended that schools should organize and/or sponsor teachers' attendance to trainings, conferences, seminars, and workshops to help them access new innovative teaching approaches in their field.

Keywords: Physics Teachers; Innovative Teaching Methods; Awareness; Utilization

1. Introduction

Physics and mathematics are compulsory subjects offered at both senior secondary schools and foundation levels of science disciplines in tertiary institutions. While physics studies the natural world, helps mankind to understand the fundamental laws and principles that govern the behaviour of the universe and explains many everyday activities and processes on Earth (Halliday et al, 2014), mathematics involves the study of quantity, structure space and charge and employs logic and reasoning to solve problems and understand the world (Jayanthi, 2019). Physics and mathematics are related and their principles have vast applications across many fields, playing important roles in everyday life and industries. Physics uses mathematics to describe and model natural phenomena while mathematics are applied in physics for construction, architectural and engineering designs and transport to mention but a few. No wonder there is a field of study known as mathematical physics. Physics therefore provides the framework for understanding the natural worlds, while mathematics on the other hand provides the instrument for quantifying and describing it, resulting in real-world applications.

Physics and mathematics education involves teaching and learning physics and mathematics respectively and involves various methods and strategies adopted by the teacher to help students understand the basic concepts as well as problem sets. Teaching science frequently falls short in engaging learners, leading to lack of in-depth understanding and limited acquisition of basic and required skills (Ndihokubwayo et al., 2022). Teaching and learning physics and Mathematics can be difficult because of its abstract and complex nature; and students often perceive the subjects as

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difficult (Badruldin et al, 2022; Bouchée et al., 2022; Mohammed et al, 2023; Wangchuk et al, 2023; Taangahar & Okwori, 2022; Chand et al, 2021; Akongu et al, 2020; Li & Schoenfeld, 2019; Nava & Camarao, 2017). This difficulty Perception of students of physics and Mathematics as difficult may reduce their interest and affect their performance in the subject. According to Deslauriers et al, (2019), and Bouchée et .al (2022), students' negative attitudes are attributed more to using traditional instructional approaches.

Both physics and mathematics disciplines require many similar skills like problem solving, critical skills and critical thinking skills, computational skills, statistical evaluation and testing of hypotheses, (IET, 2020) and observations of reports indicate lack of significant performance and achievement. This persistent phenomenon has necessitated the development and adoption of innovative teaching and learning methods. Teaching a course through an interdisciplinary approach may help students boost self-esteem (Low, 2024; Deslauriers et al, 2019). Learning interest in any subject/course will be boosted by good instructional software designed with the knowledge of applicable ideas (Saka, 2011). Innovative strategies differ from the conventional ones in that they are more student centered, more engaging (Moore et al, 2023; Opesemowo & Ndlovu, 2024).

The list of innovative methods is evolving and include among others those shown in figure 1.

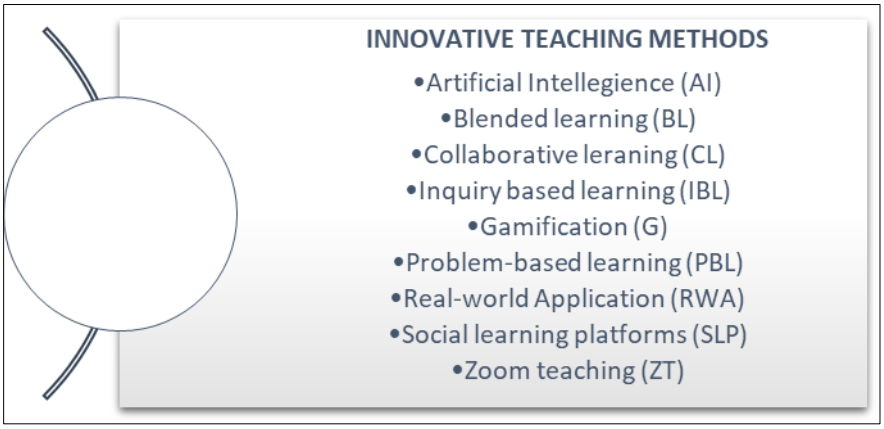

Figure 1 Innovative teaching methods (ITMs) available for teaching and learning

1.1. Adapted from various sources

Different studies have been conducted on the use and impact of innovative methods, either singly or in combination on students' learning outcome:

Artificial Intelligence (AI) in education has features such as personalized learning, which makes it possible to adapt to the needs and abilities of individual students. It also has intelligent tutoring systems that provides real-time feedback and guidance (Tsai & Tsai, 2018); enabling teacher support and enhanced learning experience (Nguyen et al, 2024; Okunade, 2024; Vorsah & Oppong, 2024; Lee, 2023; Zhang & Asian, 2021)). According to Vorsah & Oppong (2024), AI-powered tools, including intelligent tutoring systems, virtual laboratories, and adaptive learning platforms, empower teachers to deliver personalized learning experiences that foster deeper student engagement. With real-time feedback and individualized learning paths, these technologies enhance interactivity and effectiveness in ways traditional methods can't match. Applications can be seen in the Khan Academy's AI-powered math tutoring Intelligent tutoring systems that provide personalized feedback and guidance.

Inquiry Based Learning (IBL) model is one that is centered on the student and requires the ability to think in finding a concept. Numerous studies have demonstrated that IBL significantly improves student performance in physics. Erni et al (2023) studied the effect of using guided inquiry-based E-LKPD and concluded that guided IBL positively impacts learning outcomes and fosters interest in student learning. Nisa et al (2023) equally reported that implementing IBL in physics education significantly improved student achievement as it enabled them to develop critical thinking skills, foster active participation, and equipped them with problem-solving abilities needed for them to succeed academically. In the same vein, Suana (2022) reported that the use of IBL in physics education enhanced student achievement by promoting skills in problem-solving, construction of knowledge, and reasoning. The study showed significant improvements in students' cognitive abilities, indicating that IBL is effective in increasing learning outcomes and student's satisfaction. Furthermore, Planinić et al (2024) evaluated the use of IBL in physics education and observed that IBL enhanced student achievement significantly by improving their understanding of concepts, fostered positive

attitudes, and encouraged engagement. The study found that students exposed to IBL-based teaching of wave optics concepts performed better than those taught using the traditional method. A study conducted in Kenya revealed a strong positive correlation between the use of IBL and physics achievement, with critical thinking skills, student activeness, and group participation being the major factors that contributed to this success (Misoga et al, 2024). Similarly, research in the Philippines found that students exposed to IBL showed significant improvements in their post-test scores compared to those taught using traditional lecture methods, highlighting the effectiveness of IBL in fostering conceptual understanding (Jacalan & Castillo, 2023). In Indonesia, the implementation of guided inquiry-based learning models has been shown to enhance learning outcomes and student motivation (Beskara et al, 2024; Putra & Sonedi, 2021; Maknun, 2020).

Problem-Based Learning (PBL) is another innovative method. In PBL, relevant problems are introduced at the start of the instruction cycle and used to provide the context and motivation for the learning that follows, and this requires self-directed learning (Levers et al, 2024; Clausen, 2021). Argaw et al (2017) evaluated the effect of PBL strategy on students' problem-solving skills and its role in building their motivation, using problem solving inventory test and motivation scale to collect data for the study. Result showed that there was a mean difference between comparison and experimental groups. PBL strategy however, did not significantly induce motivation to learn physics. Focusing on management information systems courses, Kardoyo & Pramusinto (2020) proved that PBL strategy combined with classroom action research enhanced students' critical and creative thinking skills in as it promoted active learning and multi-solution strategies, encouraged creativity as well as promote self-reliance, enhancing metacognitive development in students.

Game-based learning (GBL) or Gamification is the use of games to promote learning or act as instructional material. According to Murray et al (2022) and Low et al (2024), board games are a reusable and entertaining way to directly engage students directly in science, technology, education and mathematics (STEM), but which requires careful consideration of mechanics, messages and accessibility to use to achieve the desired outcome. In a review on GBL, Suliyanah et al (2021) reviewed some literatures on the use of games in physics teaching in order to observe how effective using educational physics games (EPGs) can enhance student learning outcomes. They categorized some EPGs as not good in improving student learning outcomes. Among others, board games and cards were rated highly effective based on increase in student learning outcomes. Use of physics board games such as 'Diamond' has been reported as being quite motivating and engaging (Caardinot et al, 2022., Murray et al, 2022; Cardinot & Fairfield, 2019). The board game, 'Catch the Flight' systematically was designed by Low et al, (2024) and tested on 41 upper secondary school physics students in Perak, Malaysia to determine its impact on learning outcomes. The result suggested that the game was entertaining, easy to use, relevant, and promoted interaction while offering students a positive experience and enhanced their learning and motivation. The result of several studies show that interactive strategies are better than the conventional ones (Aniodoh & Eze, 2013) and teaching significantly improved students' performance. This suggests that interactive and structured teaching approaches may help students grasp Physics concepts better than traditional talk-chalk method (Gencheva & Tosheva, 2018; Oyelekan et al, 2017).

Despite these positive findings of ITMs, Mina & Oraiz (2024); Alessa & Hussein, (2023); Raissouni et al (2021) and Karanezi & Rapti, 2015) reported that many teachers still make use of the traditional method due to familiarity and ease of implementation. This approach, which are teacher-centered often, do not encourage student engagement, leading to loss of interest and poor performance. There is a need therefore to shift from teacher-centered to more students' engaging methods in order to enhance deeper understanding of concepts and increase their academic achievement. In view of the above, this study sought to evaluate the types of innovative methods available for teaching physics and Mathematics in selected senior secondary schools (SSS) of Ahoada- East local government area (AELGA) and Ogba/Egbema/Ndoni local government area (ONELGA), Rivers State.

1.2. Problem Statement

Despite the recognized importance of physics and mathematics in scientific and technological advancements, students' interest and achievement in the subjects remain a concern. Traditional lecture methods have been adjudged ineffective in fostering students' deep understanding and engagement. Innovative methods, such as inquiry-based learning, problem-solving, and technology integration, have shown promise in enhancing students' learning outcomes. Unfortunately, most physics and mathematics teachers may not be aware of innovative teaching methods. Even if they are aware, they may not utilize innovative methods effectively. They may equally face challenges in adopting innovative methods. However, there is a gap in understanding the level of awareness and utilization of these innovative methods among physics teachers. This study therefore aims to investigate the level of awareness and utilization of innovative methods for teaching physics and mathematics among teachers in two LGAs of Rivers state.

1.3. Objectives of the study

The main purpose of this study was to examine Physics and Mathematics teachers' awareness and utilization of innovative teaching methods in senior secondary schools. Specifically, the study seeks to,

- Ascertain physics and mathematics teachers' awareness on innovative teaching methods (ITMs) in public and private senior secondary schools.
- Evaluate physics and mathematics teachers' extent of utilizing innovative teaching methods in their classroom delivery in public and private senior secondary schools.
- To determine whether physics and mathematics teachers differ in their level of utilization of innovative teaching methods in AELGA and ONELGA?

1.4. Research Questions

- What is the level of physics and mathematics teachers' awareness on innovative teaching methods?
- To what extent do physics and mathematics teachers utilize innovative teaching methods?
- Do physics and mathematics teachers differ in their level of utilization of innovative teaching methods in AELGA and ONELGA?

1.5. Research Hypothesis

- Physics teachers in public and private secondary schools do not significantly differ in their level of awareness of innovative teaching methods
- Teachers in public and private secondary schools do not significantly differ in their level of utilization of innovative teaching methods
- Physics and mathematics teachers in AELGA and ONELGA do not differ significantly in their rate of innovative teaching methods utilization

2. Methodology

This study adopted a descriptive survey design using physics and mathematics teachers in Ahoada-East Local Government Area (AELGA) and Ogba/Egbema/Ndoni local government area (ONELGA) in Rivers State. The study population comprised all science teachers from ten (10) secondary schools in AELGA and ONELGA. The study sample was 70 physics and mathematics teachers, which comprised 40 teachers from public schools and 30 from private schools randomly selected from secondary schools in AELGA and ONELGA. Data for the study was obtained via the use of a 4-point structured questionnaire of very high extent (4), high extent (3), very low extent (2) and low extent (1). The questionnaire was divided into three sections, A, B and C. Section A assessed the level of teachers' awareness of innovative teaching methods; B evaluated the extent to which the teachers utilize innovative teaching methods (ITMs) in instruction while C investigated the extent to which the teachers in AELGA and ONELGA varied in their extent of ITMs's utilization. Data from responses were analyzed using mean, standard deviation and paired t-test. A mean score of $\geq$2.70 was rated high level, $\geq$2.50 as moderate level, and <2.50 as low for research items. An alpha level <0.05 was accepted as significant difference in the paired t-test.

3. Results

- **Research Question 1:** What is the level of physics and mathematics teachers' awareness on innovative teaching methods?

Table 1 Showing Physics Teachers' Awareness on Innovative Teaching Methods in public and Private Secondary schools

		Public school				Private school			
		N	**Mean**	**Std. Dev.**	**Decision**	**N**	**Mean**	**Std. Dev.**	**Decision**
1	AI education (AI)	40	2.15	1.08	Low level	30	2.20	1.10	Low level
2	Blended learning (BLS)	40	2.10	0.96	Low level	30	2.57	1.07	Moderate level

3	Collaborative learning (CL)	40	2.25	0.90	Low level	30	2.77	1.14	High level
4	Gamification (Games)	40	1.93	0.92	Very low level	30	1.80	0.85	Very Low level
5	Inquiry based learning (IBL)	40	2.75	1.13	High level	30	2.73	1.14	High level
6	Peer Review & Feedback (PRF)	40	2.23	1.03	Low level	30	2.27	1.05	Low level
7	Problem based learning (PRF)	40	2.70	0.99	High level	30	2.53	1.07	Moderate level
8	Real world application (RWA)	40	2.50	1.06	Moderate level	30	2.43	1.04	Low level
9	Social learning platform (SLP)	40	2.13	1.02	High level	30	1.83	0.83	Very Low level
Grand mean		2.30				2.34			

From Table one, teachers in public schools rated gamification (G) as very low level of awareness (mean <2.0), while AI, Blended learning (BL), collaborative learning (CL), and peer review (PR) were rated low levels, and problem- based learning (PBL) (mean, <2.50), Real world application (RWA) and social learning platforms (SLP) were rated high level (Mean>2.50). On the other hand, there were very low awareness levels for gamification, and SLP, low awareness for AI, PRF, RWA, and high levels of awareness for CL, IBL and PBL. Cumulatively, levels of awareness of ITMs were adjudged low (mean=2.30 and 2.34) for teachers in public and private schools respectively.

- **Research Question 2:** To what extent do Physics and Mathematics teachers utilize innovative teaching methods?

Table 2 Showing Physics Teachers' Utilization of Innovative Teaching Methods

	Public schools (n-40)					**Private school (n-30)**		
	ITM	**Mean**	**Std. Deviation**	**Decision**		**Mean**	**Std. Deviation**	**Decision**
Pair 1	AI	1.80	0.71	VLE	AI2	1.90	0.98	VLE
Pair 2	BLS1	2.43	0.90	LE	BLS2	1.73	0.68	VLE
Pair 3	CLS1	2.47	0.82	LE	CLS2	1.70	0.83	VLE
Pair 4	Games1	2.63	0.89	ME	Games2	1.87	0.97	VLE
Pair 5	IBL1	2.40	0.93	LE	IBL2	2.63	1.09	HE
Pair 6	PRF1	3.13	0.86	HE	PRF2	1.96	1.07	LE
Pair 7	PBL1	1.67	0.80	VLE	PBL2	2.50	1.07	ME
Pair 8	RWA1	2.13	0.57	LE	RWA2	2.23	0.95	LE
Pair 9	SLP1	2.47	0.97	LE	SLP2	2.63	0.89	ME
Grand mean		2.35				2.13		

Key: LE-low extent, VLE-very low extent, HE-high extent; ME-moderate extent; 1=public school, 2-private school

Result in table 2 reveals varying responses on the level of utilization of innovative teaching methods (ITMs) by physics teachers. AI and problem based learning (PBL) were rated very low extent (mean<2.0), in public schools, while AI, BLS, collaborative learning (CL) and use of games were rated very low extent (mean<2.00)., BLS and SIP indicating that they have not utilized blended learning approach in teaching of Physics lessons. Cumulatively, levels of utilization of ITMs were adjudged low (mean=2.35 and 2.13) for teachers in public and private schools respectively, although the level is slightly higher in public school.

- **Research question 3:** Do physics and mathematics teachers differ in their level of utilization of innovative teaching methods in AELGA and ONELGA?

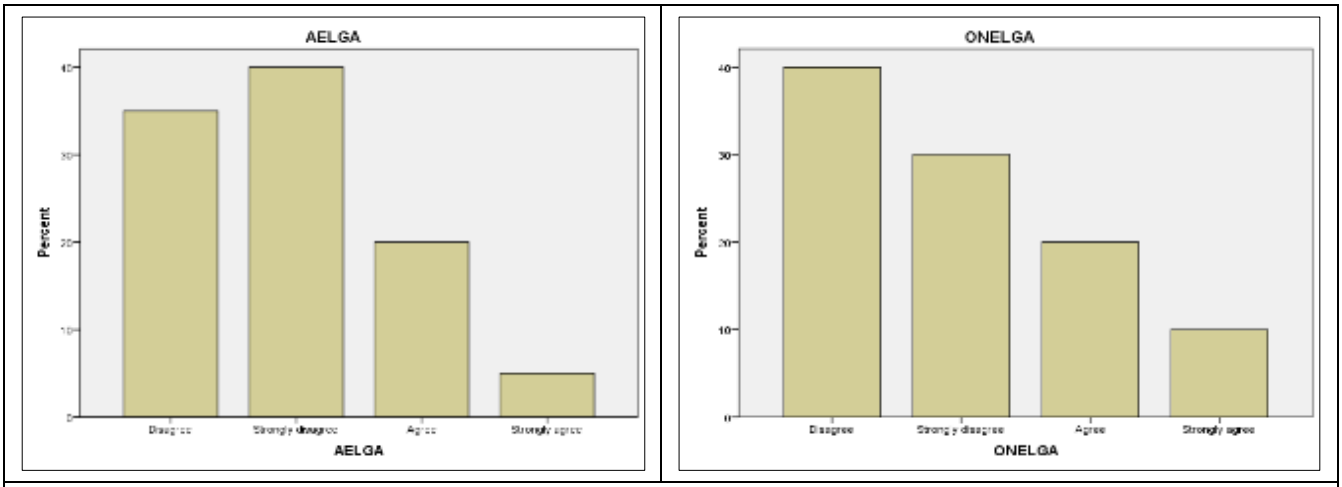

Figure 2 Innovative teaching methods (ITMs) utilization rate in AELGA (mean=1.95) and ONELGA (mean=2.00)

From the chart in Figure 2, the percentage of respondents who accepted that they utilized ITMs were 25% and 70% in AELGA and ONELGA respectively, indicating low extent of utilization.

3.1. Hypothesis Testing

- Hypothesis 1. There is no significant difference between teachers in public and private school teachers in their innovative teaching methods level of awareness

Table 3 Paired Samples Test on ITMs' Awareness in public and private secondary schools

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	AI Awareness (pub) - AI awareness(priv)	-0.53	1.20	0.22	-0.98	-0.09	-2.44	29	0.02
Pair 2	Blended learning (pub) - Blended learning (priv)	-0.90	1.32	0.24	-1.39	-0.41	-3.73	29	0.00
Pair 3	Collaborative learning (pub) - Collaborative learning (priv)	-0.87	1.38	0.25	-1.38	-0.35	-3.43	29	0.00
Pair 4	Gamification (pub) - Gamification (priv)	-0.10	1.03	0.19	-0.48	0.28	-0.53	29	0.60
Pair 5	Inquiry based learning (pub) - Inquiry based learning (priv)	-0.40	1.19	0.22	-0.85	0.05	-1.84	29	0.08
Pair 6	Peer Review & Feedback (pub) - Peer Review & Feedback (priv)	-0.97	1.07	0.20	-1.37	-0.58	-4.97	29	0.00
Pair 7	Problem based learning (pub) - Problem based learning (priv)	0.40	1.38	0.25	-0.12	0.92	1.59	29	0.12

Pair 8	Real world application (pub) - Real world application (priv)	-0.17	1.37	0.25	-0.68	0.34	-0.69	29	0.51
Pair 9	Social learning platform (pub) - Social learning platform (priv)	0.03	1.07	0.20	-0.37	0.43	0.17	29	0.87

Key: pub=public (Govt owned institution); priv =privately-owned school

Of all pair of ITMs, only in items 1 (AI), 2 (BL), 3 (CL) and 6 (PRF) were there significant differences between the teachers in public and private schools ($p<0.05$), whereas no significant difference was observed in the area of gamification, inquiry-based learning, problem-based learning, real world application and social learning platform. Based on the summary T-test statistic in Table 4, there was no significant difference in the level of awareness of physics and mathematics teachers in public and private secondary school in AELGA and ONELGA

Table 4 Summary paired t-test on ITMs Awareness

		Paired Differences					**T**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Dev.**	**Std. Error Mean**	**95% Confidence Interval of the Difference**				
					Lower	**Upper**			
Pair 1	Public school Private school	-0.04	0.28	0.09	-0.26	0.17	-0.47	8	0.65

- **Hypothesis 2:** Teachers in public and private secondary schools do not significantly differ in their level of utilization of innovative teaching methods

Table 5 Paired Samples T-Test for ITMs utilization in public and private schools

		Paired Differences			**95% Confidence Interval of the Difference**		**T**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Dev.**	**Std. Error Mean**	**Lower**	**Upper**			
Pair 1	Public - private	0.22	0.65	0.22	-0.28	0.72	1.02	8	0.34

Summary of paired t-test (Table 5) indicates lack of significant differences in the mean utilization levels of physics and mathematics teachers in public and private schools ($p>.05$)

3.2. Hypothesis 3

Teachers in AELGA and ONELGA do not significantly differ in their rate of utilizing Innovative teaching methods

Table 6 Paired sample test for ITMs utilization by teachers in AELGA and ONELGA

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Devi.	Std. Error Mean	95% C.I. of the Difference				
					Lower	Upper			
Pair 1	ITMs utilization AELGA - ITMs utilization ONELGA	0.50	2.12	1.50	-18.56	19.56	0.33	1	0.79

There was no significant difference in the rate of ITMs mutilation by teachers in AELGA and ONELGA (p>.05)

4. Discussion

The level of awareness of teachers in innovative teaching methods (ITMs) is important for effective implementation of modern educational practices. In this study, the awareness levels for ITMs were generally very low except for IBL and PBL. Thie low level of awareness in this study agrees and /or disagree with reported literatures: For instance, Achor et al (2010) observed that many teachers in Benue State, Nigeria are aware of ITMs (high level), but were limited in their actual utilization of these methods. Similarly, Bhunia & Paul (2023) in their study on awareness level of blended teaching -learning among secondary school teachers in West Bengal reported that it was low and varied based on gender, locality, teaching experience, and educational stream. They also observed that the male teachers have significantly greater awareness towards BL than female teachers; urban teachers have significantly better awareness than rural teachers; teachers with lesser teaching experience have better awareness than those with greater teaching experience; and science teachers has better awareness. Ogunji et al (2019) further revealed a significant low level of awareness among academic staff regarding innovative teaching methods in universities in south-eastern Nigeria, indicating that many educators are not familiar with or utilizing these pedagogies effectively in their teaching practices.

Likewise, John (2024) reported that teachers in Tanzania had theoretical knowledge of innovative methods like blended learning (BL) and mobile learning (ML), but their implementation was hindered by infrastructure and training limitations. Students acknowledge that these methods enhance engagement and flexibility in learning, although their implementation is not yet uniform across all schools. Comparing schools in different locality, Rasha et al (2023) reported that mathematics teachers in the Saudi Arabia and the Arab Republic of Egypt were highly aware of effective teaching strategies and practices, and that females having level.

Utilization of AI tools in this study was is very low. The level of awareness and utilization of AI tools in education is evolving, with significant potential for enhancing teaching and learning experiences. Recent studies indicate that while awareness of AI tools like ChatGPT is increasing among students and educators, actual utilization data is not consistent because of certain challenges. Many students in physics and mathematics education are becoming familiar with AI tools, particularly chatbots, which are used for problem-solving and coding assistance (Trout & Winterbottom, 2024; Lopez et al, 2022; Moore et al, 2023). Asongo et al (2024) reported that AI tools use levels vary significantly based on educational programmes, with postgraduate students showing differing degrees of familiarity with AI tools. Mustofa et al, (2024) and Li & Manzari (2025) in their independent studies indicate a growing awareness and utilization of AI tools in physics education and mathematics education respectively and that it enhanced lesson planning and problem-solving skills. However, challenges remain, and these include inaccuracies and the necessity for human intervention, highlighting the need to balance AI integration with traditional methods (Hidayat et al, 2022; Opesemowo & Ndlovu, 2024).

On the contrary, Fashola (2024) investigated AI tools awareness, perception, and use by LIS educators and reported high awareness and positive perception. The actual usage was however limited due to various challenges faced. Furthermore, Musa et al (2021) in a study revealed that secondary school teachers were only aware of 5 out of 28 innovative instructional strategies and never utilized them. The study indicated that the teachers have varying levels of awareness regarding BLS. It equally showed that male, urban, and less experienced teachers have more awareness compared to their female, rural, and more experienced colleagues.

5. Conclusion

The findings reveal that physics and mathematics teachers in AELGA and ONELGA generally have a low level of awareness of innovative teaching methods like project-based, inquiry-based, active, collaborative, and problem-based learning. These findings appear to be consistent with the majority of observations reported in literatures. Also, the use of the identified ITMs in this study were also generally low. The study found no significant difference in awareness and utilization levels between teachers in public and private secondary schools as well as in AELGA and ONELGA.

Recommendations

Based on the findings, the study recommends the following:

- Teachers should be exposed to innovative teaching methods through engagement in trainings and workshops
- Teachers should be motivated to adopt innovative teaching methods in their classroom delivery.
- Professionalism should be introduced and only certified and trained teachers with their TRCN certificate should be recruited without bias.
- Physics and mathematics teachers should continually update their knowledge on ITMs

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