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The Efficacy of Mathematics Instructional Materials in Teaching and Learning of Mathematics Students: Implications for Measurement and Evaluation Instruction

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Abstract
This study investigated the efficacy of instructional materials in enhancing teaching and learning of mathematics for Secondary School students. Instructional materials have been identified as very beneficial to the process of instructional delivery. The importance of instructional materials in the process of teaching and learning for the improvement of student's academic performance cannot be taken for granted. Descriptive survey research design was employed and 650 mathematics teachers and students participated in the study (n = 250 Teachers, n = 400 Students). Two instruments; Instructional Materials for Enhancing Teaching of Mathematics Questionnaire (IMETMQ) and Instructional Materials for Enhancing Learning of Mathematics Questionnaire (IMELMQ) were used for collecting data immediately after classroom interaction. The instruments were trial tested and the internal consistency reliability coefficients of 0.87 and 0.82 were obtained using Cronbach alpha method. Use of instructional materials enhances teaching of mathematics as well as the learning of mathematics by students. The result equally showed that mathematics teachers as well as students' gender respectively influenced the extent of efficacy of instructional materials on the teaching and learning of mathematics. Male teachers have a mean value of (n=125, $\overline{X}$=3.46, SD=0.27) while the female teachers have mean value of (n=125, $\overline{X}$=3.09, SD=0.18). Mathematics teachers should integrate instructional resources when teaching for improvement and academic success of students. Adequate instructional materials should be provided by the school authorities to ensure effective teaching and learning of mathematics by students.
Keyword: Instructional materials, mathematics education, mathematics teachers, measurement & evaluation, students, teaching & learning

INTRODUCTION
The Efficacy of instructional materials in the teaching and learning of mathematics has been a subject of research debate in the realms of teacher education, especially in the training of

mathematics teachers. The discourse became relevant with the enormous role of mathematics as an indispensable subject on which the understanding of science and other quantitatively related fields of study is premised, especially measurement and evaluation. Buttressed by Suleiman and Hammed (2019), the effectiveness of mathematics instruction forms the rubrics for the understanding of shapes, patterns, measurements in addition to counting and its ability to increase an individual`s intellectual ability by developing the habit of accuracy, sharp reasoning, mental alertness and minimizing chance of carelessness; as well as improve the skills of critical thinking, logical and analytical reasoning, and enhance the comprehension of abstract logic. This views align with the mathematics instruction objectives stipulated by the Nigerian Educational Research and Development Council ([NERDC], 2013), which include to develop in learners the interest of learning mathematics and provide a foundation that is solid and foundational for everyday living; develop computational skills and foster skills of precision, logical and abstract thinking in handling problems and encourage creativity. Unfortunately, students' achievement in mathematics over the years continue to suffocate, implying that these objectives may only be a mirage if no intervention is employed to truncate the scourge of poor achievement in mathematics. In this situation, one begins to question the effectiveness of the existing interaction between teachers and student in our schools with a view to probe the learning experiences students are exposed to, which Andriyani and Maulana as cited in Buliali et al., (2022) have suggest affects the quality of knowledge acquired from the instructional process.

Instructions dispensed in the course of teaching are the foremost weapon teachers employ for instilling the desired change in behaviour which students need to propel the desired achievement in mathematics. However, the issue is often confounded with the way mathematics lessons are taught. One will expect that the focus is on the effectiveness of the teaching and learning of mathematics. In essence, teaching of mathematics could be more effective with approaches that encourage students to make efforts to learn mathematics properly. The concept of teaching goes beyond mere interaction between teachers and learners to active engagement with learners to facilitate their understanding and application of knowledge to solve real life problems (Stellenbosch University [SU], 2022). Effective teaching of mathematics ought to result in improvement in learners' cognitive, affective and psychomotor learning domains. According to Management Study Guide Team ([MSGT], 2021), learning may be seen as a relatively permanent change in learners' behaviour due to exposure to experiences. Obvious in the view of Sequeira (2012), who infer learning as changes that occur in an individual as a result of the development of new skills, understanding of laws and processes. Within this study, learning is conceptualized as structures that ensures improvement in an individual`s behaviour, attitude and abilities as a result of effective instructional interactions between the teacher and learners. There has been a handful of indication that students' engagement in the processes which connote teaching and learning are necessary for improvement and academic success.

Considering the role of these instructional processes, there is need to ensure continuous improvement in teaching as well as learning processes. One of such means through which teaching and learning of mathematics could be made effective is through the use of effective and durable instructional materials. Instructional materials have been identified as very beneficial to the process of instructional delivery. According to Tuimur and Chemwei (2015), instructional resources are materials used by the teacher for the purpose of simplifying teaching. This definition sees instructional materials as a facilitator of teaching only without reference to learning. Shukla (2021) states that instructional materials are tools used to facilitate the transmission of information through the act of teaching and learning. Thus, instructional material may be considered as any tool or a collection of tools used for the purpose of making teaching easier for teachers and to facilitate or simplify learning for students. According to (Author), instructional aids include such resources as textbooks, pictures, electrical devices, among others.

Instructional materials are essential resources used by teachers to support teaching and learning in the classroom. They can take various forms such as textbooks, workbooks, worksheets, audiovisual materials, and technology-based resources. The selection and use of instructional materials play a crucial role in engaging students, enhancing their understanding, and facilitating their learning. In terms of best practices for selecting instructional materials, Hesser et al. (2020) emphasized the importance of considering factors such as alignment with curriculum standards, accessibility for diverse learners, and relevance to students' interests and backgrounds. Generally, research suggest that high-quality instructional materials play a critical role in supporting effective teaching and learning in the classroom. Hence evidence from research encourage educators to carefully evaluate and select materials that meet the specific needs of their students and enhance their learning experiences. Recently, several studies discuss the importance of instructional materials in education. Shalem et al. (2021) examined the impact of using interactive instructional materials on student learning outcomes in mathematics and found that students who used interactive materials showed significant improvements in their performance compared to those who did not. Yilmaz and Tanir (2020) explored the use of digital instructional materials in language teaching and learning, and found that digital materials enhanced student motivation and engagement, leading to improved language skills acquisition.

Scholars have variously categorized instructional materials, based on their conceptualization. According to Shukla (2021), instructional materials are broadly categorized into two, electronic or digital (computers, mobiles, slideshow, among others); and non-electronic (chalkboard, flip boards, slates, print photos, , among others). The author further sub-classified electronic instructional resources to include auditory (radio, tape recorders, CD players, etc.); audiovisuals, tactile and collaborative social or interactive (YouTube, Ted Talks, Instagram, Tik Tok, Documentary repositories etc.); audiovisuals and tactile (3D models, filed visits, toys, etc.); and collaborative/social (online classrooms, forums, Facebook pages, Quora spaces, virtual meetups, etc.). These classifications show that any resource or material that enhances the process

of teaching and learning is an instructional aid. In essence, teaching and learning would remain relatively barren if there were no instructional aids. To choose an appropriate learning method, teachers need to consider limitations, interest in learning, and whether the teaching materials used are interactive or not (Buliali et al., 2022). According to Hasanah et al (2017), teaching materials used by teachers must facilitate the needs and accommodate the unique characteristics of students.

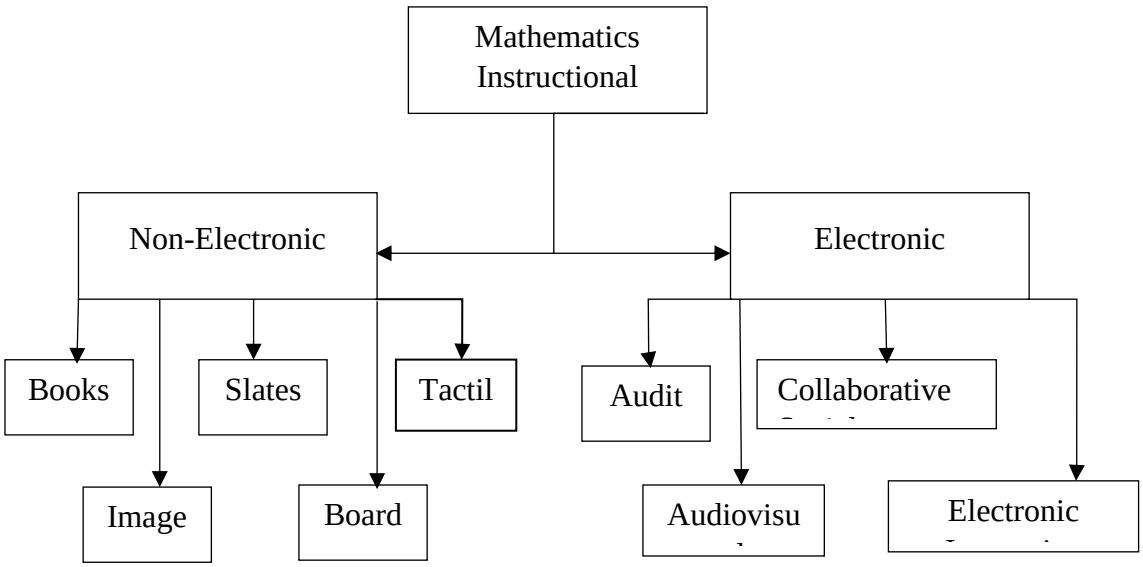


Figure 1, Conceptual schema of Mathematics instructional materials

The schema in Figure 1 shows the conception of mathematics instructional materials. Two broad spectrum of instructional materials upheld in literature are the electronic and non-electronic instructional materials which can further be subdivided into sublets of books, images, slates, boards and tactile instructional materials for the non-electronic category while the electronic category is construed as auditory, audiovisual, collaborative social and electronic interactive instructional materials.

Printed materials put together texts and symbols on pieces of paper bound together for the purpose of providing access to information from the writer to the reader. These prints of several pages make up a book. Research has consistently confirmed the continued relevance of books as instructional materials in various educational settings. They play a crucial role in providing information, enhancing understanding, and fostering independent learning among students, and continue to be a valuable resource for aiding assimilation and retention of instruction. Channa and Anjum (2019) assert that the use of books in teaching mathematics found that textbooks were the most commonly used instructional material in mathematics classrooms. Also, Kumar and Khan (2020) highlighted the effectiveness of using books as supplementary materials in language teaching; incorporating additional reading materials, such as novels and short stories, improved students' language skills and comprehension levels, books are a valuable resource for practicing

reading, writing, and vocabulary acquisition in language learning. Channa and Anjum emphasized the importance of textbooks in providing a structured and comprehensive overview of the subject, helping students understand key concepts and practices. Textbooks, notebooks, story books, workbooks and other many categories of books are often used for educational purposes. Especially in mathematics, textbooks, workbooks and notebooks are specifically more useful for teaching and learning.

Textbooks have been identified as important instructional materials which are necessary tools through which students gain access to the knowledge and skills specified in the content standards in the curriculum. According to Kovač et al. (2005), textbooks are a textual teaching medium and part of educational tools that aids both, the efficiency of teaching as well as individual learning, whereas, to Gak (2011) textbooks are some of the numerous sources that enable teachers to provide quality teaching. Pravilnik o potrjevanju učbenikov as cited in Mithans (2020) defined a textbook as the main teaching material to achieve the educational objectives and standards of knowledge specified in the curriculum. Although textbooks are often used in schools to guide teachers and students through the curriculum, textbooks are used in teaching mathematics because they provide a structured approach to learning mathematical concepts. Therefore, in this study, all readable printed or electronic materials which can contribute to the attainment of the goals of the curriculum make up the host of textbooks. Oakes and Saunders (2002) point out that even studies across national borders have established the educational importance of textbooks as instructional materials.

To meet the educational standards and pass the stakes of the prescribed tests based on curricular requirements, students require to gain the knowledge that is contained in textbooks to develop particular skills by interacting with instructional equipment and technology. Mathematics textbooks adapt the language structure and the content to the developmental stage of the learners it is designed for. Also, the range of problems and the level of complexity in such textbooks are designed to comply with the average developmental stage of the learners (Ivanuš Grmek, 2003). One may then believe that textbooks as an important educational tool are useful for transmitting knowledge to many further generations. However, a stack of textbooks in library shelves is useless until they are used to bailer relevant information that confers relevant knowledge to the user which align with the educational goals of the curriculum. Figure 2 shows students using textbooks, workbooks and exercise books for learning under the teacher's guidance. These books are necessary learning materials for teaching and learning in schools. Students in schools require books to take notes and retrieve information during and after the lessons, educators believe this helps students achieve better mastery and retention of the subject matter.

Figure 2. Students using textbooks, workbooks and notebooks in the classroom under the teacher's guidance

Figure 3. Teacher guiding students in attempting workbook problems in classroom (Source: Vanguard, 2019)

Often, mathematics textbooks are accompanied with students' workbooks as seen in Figure 3. Teachers often use workbook exercises to engage students for further and extended learning activities beyond the immediate classroom of instruction. Workbook is another type of instructional material that is used to provide students with additional practice and reinforcement of mathematical concepts. Workbooks are popular choices among educators for their systematic approach to building mathematical skills. Workbooks have surfaced as a valuable instructional tool in education, with recent research highlighting their effectiveness in engaging students and enhancing learning outcomes. Albanesi et al. (2018) found that the use of workbooks in the classroom increases student motivation and participation, particularly among learners. Also, Dindyal and Konaté (2020) is of the opinion that workbooks in mathematics education and emphasized the importance of incorporating hands-on activities and real-world examples to enhance student understanding and retention of mathematical concepts. The authors also highlighted the potential of workbooks to promote self-directed learning and mastery of skills. Furthermore, Bautista and Taylor (2019) emphasized the role of workbooks in providing scaffolded practice and reinforcement of language skills, as well as opportunities for students to engage in authentic language use through meaningful activities and tasks. Many more research on workbook instructional materials continues to demonstrate their effectiveness in supporting student learning and achievement across various subject areas. By incorporating innovative strategies and technology-enhanced features, educators can leverage workbooks to create engaging and interactive learning experiences that meet the diverse needs of today's learners.

Most textbooks in recent times do not contain just prints of letters and numbers but also picture images which finely elucidate the concept being discussed. Pictures are a powerful tool in instructional materials due to the immense help pictures offer in conveying information in a visual and engaging way for learners of all ages. Studies have shown that visuals can enhance learning and retention by helping to clarify concepts and make information more memorable. Nguyen et al. (2020) found that students who were provided with picture images along with text-based instructions showed better understanding of algebra concepts and performed better on tests compared to students who received text-based instructions alone. Also, Smith and Jones (2019) found that incorporating visual picture images, such as infographics and diagrams, into the course materials helped to increase engagement and comprehension among learners, leading to improved learning outcomes. Learners can also improvise images and diagrams on their slates. Figure 4 shows a teacher using a picture as instructional material to deliver learning content to students in the classroom. From the figure, students can be seen to be engaged in the lesson, judging by their curiosity and attention to the teacher, one can say that learning is making sense to the learners.

Figure 4. Teacher using pictorial instructional material in the classroom

Slates are mostly used for beginners in cradle schools in Nigeria and are popular in the education sector due to their versatility and interactive features that enhance learning experiences. Although slate materials can be digital too, they support various instructional strategies, such as personalized learning, flipped classrooms, and blended learning. Staker and Horn (2017) explored the use of slate instructional materials in K-12 education and found that they can improve student engagement, achievement, and empowerment. Molnar et al. (2020) found that adaptive features of slates such as personalized feedback, progress tracking, and interactive assessments, helped students learn at their own pace and improve their academic performance. Penuel et al. (2021) discussed the potential of slate instructional materials in promoting equity and inclusion in education, and emphasized the importance of creating culturally responsive content, ensuring accessibility for all students, and addressing learning divides to ensure equal access to learning opportunities, especially in cases where the blackboard is far from the students. Slates are widely used in primary and nursery schools where the emphasis is on memorization. As seen in Figure 5, learners can be seen making efforts to imitate their teacher on the slate with approaches that enhances memorization.

Figure 5. Teacher using slate instructional material in the classroom

Blackboard is a popular instructional and learning management system used by many educational institutions to deliver lessons and provide a platform for interactive learning. Instructional materials on Blackboard can include course lectures, readings, assignments, quizzes, discussion boards, and multimedia resources. These materials are designed to engage students, facilitate learning, and provide a platform for communication between teachers and students. Nouri et al. (2021) examined the use of blackboard as a tool for the delivery of instruction and found that Blackboard was effective in supporting learning and providing a platform for teachers to interact with students and deliver course materials. Also, Kim and Bonk (2020) explored the use of blackboard to display interactive multimedia materials, to enhance student engagement and learning outcomes and found that incorporating multimedia resources such as videos, simulations, and interactive activities on Blackboard led to increased student participation and improved comprehension of course content. Furthermore, Al-Emran et al. (2021) highlighted the importance of providing clear instructions, organizing materials logically, and engaging students through interactive activities and discussions on blackboards to enhance students' learning. However, some studies have shown that the use of images on blackboards does not really equate the educational benefits of hands-on interactive tactile learning materials that students manipulate while learning. Figure 6 shows a teacher using blackboard instructional materials for teaching students in the classroom.

Figure 6. Teacher using blackboard instructional material in the classroom

Away from the blackboard and in books, a number of studies in literature support the role of practicing with real-world learning materials for the purpose of concrete experiences and drawing curious sensitivities from the tactile learning materials. Tactile materials are concrete manipulative objects that can be used to help students visualize and explore mathematical concepts. Evidence suggest that research on tactile instructional materials is limited. Tactile materials are physical hands-on resources designed to engage students' sense of touch. However, Clements and Sarama (2007) have shown that using manipulatives in teaching mathematics can improve students' understanding and retention of mathematical concepts. Popular manipulatives used in mathematics education include base-ten blocks, fraction tiles, and geometric solids. More so, there have been some recent studies that have explored the benefits of using tactile materials in education. Foster et al. (2019) investigated the impact of tactile materials on learning outcomes for students with visual impairments, and found that tactile materials helped improve spatial reasoning skills and comprehension of abstract concepts for these students. Also, Wang et al. (2020) explored the use of 3D-printed tactile models in STEM education and found that tactile models enhanced students' understanding of complex scientific concepts and improved their retention of information. Jones et al. (2021) emphasized the importance of providing tactile materials that are age-appropriate, culturally relevant, and accessible to students with diverse learning needs. While more research is needed in this area, studies suggest that tactile instructional materials can be effective in enhancing students' learning experiences. Such tactile learning

materials are often physical and non-digital, yet still effective, although a myriad of studies crave the heralding of digital technologies in teaching and learning endeavours.

Figure 7. Teacher and learners using tactile instructional material in the classroom (Source: Splashlearn, 2024)

Beyond physically mechanical instructional materials, the trend in times avails for electronic devices in almost all spheres of life, especially in the classroom for learning purposes. Having imbibed electronic instructional materials in the classrooms, one would expect the impasse of digital technology in the modern day learning space. Unfortunately, most developing countries, like Nigeria where the current study is conducted struggle with implementing the infrastructural models which support most electronically driven instructional materials. The scope of electronic instructional materials viewed in this study encapsulates auditory, audiovisual, collaborative social and electronic interactive media as components of electronic instructional materials. Auditory instructional materials are resources that leverage sound as the primary means of conveying information and facilitating learning. As technology continues to advance, auditory instructional materials have become increasingly popular and adopted in educational settings. According to Loya et al., (2019), the rise of voice technology, such as virtual assistants like Amazon Alexa and Google Home, has opened up new possibilities for auditory instructional materials, with the possibility of providing personalized learning experiences and instant feedback to students, making learning more interactive and engaging. These materials can include podcasts, audiobooks, music, sound effects, and other forms of audio content that can enhance the learning experience.

According to Wu et al. (2020) the use of auditory instructional material in higher education results in higher levels of engagement and retention. Shah et al. (2021) found that the use of audiobooks as instructional materials in middle school setting induced improvements in reading comprehension and vocabulary skills compared to those who only read print materials. Generally, auditory instructional materials are a valuable tool that can enhance students' learning experience and improve student engagement and retention. With the advancement of technology and research supporting their effectiveness, educators have started considering incorporating auditory materials into their teaching practices to optimize learning outcomes.

Figure 8. Teacher and learners using audio instructional material in the classroom (Source: Shutterstoch, n.d.)

Further from the realm of audio devices are audiovisual instructional materials. These are resources that combine both auditory and visual elements to enhance the learning experience. Audiovisual instructional materials combine moving pictures with sound in tandem with motion (Wang et al., 2021; Phinney et al., 2021). These materials can include videos, animations, slideshows, multimedia presentations, and virtual reality, among others. With the increasing accessibility of technology, audiovisual instructional materials have become more prevalent in educational settings as they provide a more engaging and interactive way to deliver content. Wang et al. (2021) investigated the impact of using videos as audiovisual instructional materials in a university setting and found that students who were exposed to video-based instructional materials showed higher levels of engagement, motivation, and knowledge retention compared to those who

received traditional text-based content, suggesting that incorporating videos into teaching can improve learning outcomes and overall student performance. Similarly, Van der Borght et al. (2020) investigated the use of virtual reality (VR) as an audiovisual instructional tool in a medical education context and found that medical students who used VR simulations for surgical training showed improvements in procedural skills and confidence compared to those who only received traditional training methods. This highlights the potential of VR as a powerful tool for immersive and hands-on learning experiences. According to Phinney et al. (2021) multimedia presentations enhances student understanding, comprehension and retention of complex scientific concepts. Evidence from these studies show that audiovisual instructional materials offer a dynamic and effective way to deliver content, engage students in the learning process, cater to different learning styles and enhance students' learning, especially when hosted on social media space.

Collaborative social instructional materials involve the use of interactive and participatory resources that foster collaboration, communication, and engagement among learners. These materials leverage social interactions, such as group activities, discussions, and shared projects, to enhance the learning experience and promote a sense of community among students. With the rise of the social media and online learning platforms, collaborative social instructional materials have become increasingly popular in both traditional and virtual educational settings. The findings of Wang et al. (2020) who explored the use of collaborative learning platforms as social instructional materials in higher education showed that students who participated in group-based activities on collaborative platforms demonstrated higher levels of critical thinking, problem-solving skills, and overall engagement compared to those who engaged in individual learning tasks, leading to improved learning outcomes and peer interaction. Pryor et al. (2021), examined the impact of collaborative social media instructional materials in a secondary school setting and found that incorporating social media tools, such as discussion forums and online communities, into learning activities facilitated communication among students, encouraged knowledge sharing, and enhanced peer collaboration among learners. Also, Kim and Kim (2020) investigated the use of collaborative project-based learning as an instructional strategy in a university course. Kim and Kim found that students who worked on group projects collaboratively showed improvements in teamwork skills, communication abilities, and problem-solving capabilities, underscoring the value of collaborative social instructional materials in fostering collaborative skills and preparing students for real-world collaboration and teamwork. By leveraging social interactions and collaboration, educators can enhance the learning experience and facilitate meaningful peer-to-peer engagement in educational settings. Galindo, et al. (2021) used Tutorink social network platform, Arav and Trigel (2021) used WhatsApp social network platform, while Zhang, et al. (2020) explored Facebook and Twitter social media platforms, as a collaborative learning tool tools. The researchers found that students who actively participated in these online collaborative activities through social media demonstrated increased motivation, engagement, problem solving skills and knowledge sharing, resulting in improved learning outcomes. This feat may be so

sustained because some of the collaboratives may carry interactive features as well. Figure 9 shows a frame of students learning under the guidance of a teacher using online collaborative devices. The smiles and enthusiasm on the faces of the students, as well as the teacher's expression can tell one about the fulfillment derived in the learning engagement.

Figure 9. Teacher and students using collaborative learning material in the classroom (Source: Owens & Muñiz, 2020)

Electronic interactive instructional materials refer to digital resources that allow learners to engage with content in an active and hands-on manner. These materials often leverage technology to provide learners with opportunities to interact with content, incorporate elements such as simulations, games, quizzes, interactive videos, virtual laboratories, and other interactive features to enhance the learning experience, and receive immediate feedback on their progress. Naqvi et al. (2021) investigated the impact of using gamified interactive modules in teaching computer programming to undergraduate students, and found that students who engaged with the interactive modules showed higher levels of motivation, engagement, and learning outcomes compared to those who received traditional instruction. Cheng et al. (2020) explored the use of virtual laboratories as electronic interactive instructional materials in science education, and demonstrated that students who used virtual laboratories for hands-on experiments showed improvements in understanding scientific concepts, experimental skills, and problem-solving abilities compared to those who only used traditional physical labs. Furthermore, Anderson et al.

(2019) examined the effectiveness of interactive videos in supporting student learning in a medical education context. The result of that study showed that students who watched interactive videos with embedded quizzes and decision-making scenarios had better comprehension, retention, and critical thinking skills compared to those who watched traditional instructional videos. Interactive instructional materials have been shown to enhance student engagement, motivation, and learning outcomes. Hysong et al. (2020) showed that medical students who are exposed to interactive instructional materials showed better understanding of complex medical concepts and improved clinical decision-making skills. Nguyen et al. (2021) showed that interactive video tutorials are more effective for higher levels of retention and understanding of chemical concepts in chemistry education. These evidences suggest that interactive materials can be effective in promoting active learning, providing immersive and engaging learning experiences and knowledge retention.

The process of teaching and learning could be said to be intertwined with the usage of instructional aids since it eases instructional processes and makes teaching and learning efficient. According to ("Author"), instructional materials make it easy for abstract concepts to be concretized and represented in real form. This means that instructional aids help learners improve in their understanding. Nettl of Birmingham (2009) stated that instructional resources enhance learners` motivation, ease learning, increases students ability to apply concepts in real situations, promote critical and creative thinking as well as improves the interest of learners. For illustration, the teacher in the Figure 10, perhaps rather than violates ethical considerations while using a live human for illustration, decided to use image projection for the lesson, making it convenient and easier to manipulate the learning resources while stimulating learners' attention and motivation, and still enhancing the quality of the lesson delivery.

Figure 10. Teacher and students using projection for lessons in the classroom (Taremwa, 2022)

The importance of instructional materials in the teaching and learning of mathematics cannot be taken for granted. Scholarly studies reveal the relevance of instructional materials in enhancing teaching and learning processes. In the study by Effiong and Igiri (2015), it was revealed that instructional materials simplify teaching for teachers as well as make learning easy for students. According to Adalikwu and Iokpilgh (2013), instructional materials increase students` understanding of concepts and academic performance. This means that instructional materials make learning easier for students. The authors further added that with instructional materials, teachers can easily plan instructions, assess knowledge and assign tasks to students. This is an indication that instructional materials enhance teaching. According to Crist (2014), instructional materials help teachers in every aspect of teaching, from the planning of instructions, through its delivery to the point of assessment of students. This report by Crest is an indication that instructional materials add values to teaching. Arop, et al (2014) reported that instructional materials contribute to students` learning as it increases their performance. The study by Tety (2016) also added that instructional materials are key for effective teaching and learning. While the above studies stressed on the benefits of instructional materials in facilitating teaching and learning, it has been observed that mathematics teachers particularly, do not always use instructional materials. According to Aksan and Eryilmaz (2011), mathematics teachers do not feel comfortable with instructional materials, as such, they hardly use it. Dawadi (2020) also reported that mathematics teachers do not feel comfortable in gathering instructional materials for teaching mathematics. Awoshiyan as cited in Eraikhuemen and Omoregbe (2017) stated that mathematics teachers do not use instructional materials even when they are available, and often times, they are used in ways that are ineffective. Umuhoza and Uworwabayeho (2021) reported in their study that mathematics teachers do not use instructional materials at all, and also, teachers do not allow students to actively learn with instructional materials.

The foregoing stresses the benefits of instructional materials, as an indispensable tool in the business of teaching and learning. Although the many benefits of instructional aids in teaching and learning, to achieve the objectives of instruction, instructional aids, Dienve and Asuru (2012) highlighted some qualities expected of a good instructional aid to include simplicity, attractiveness, relevance, legibility, and durability. This means that a good instructional aid must be easy to use and should simplify the process of teaching and learning, be appealing to learners, be readable and understandable, as well as be able to last or serve for a reasonable period of time. Irrespective that instructional materials have proven to be effective in facilitating teaching and learning, it is yet to be properly utilized by mathematics teachers. Most mathematics teachers teach mathematical contents without adopting or even adapting an instructional aid in the lesson. One begins to wonder, could it be that instructional materials do not enhance the teaching and learning of mathematics compared to other subjects? Or perhaps, instructional materials make the teaching and learning of mathematics difficult? In order to address this confounding query, further investigation is required to ascertain the efficacy of instructional materials in enhancing teaching

and learning of mathematics. Meanwhile, it may be possible too, that the effectiveness of instructional materials could be influenced by teachers` and students` gender.

Gender is considered as a form of identity or distinguishing characteristics, traits or attributes used to assign roles to males and females in the society. The Canadian Institute of Health Research (2021) argued that gender is capable of influencing how people view themselves and others as well as how they interact within the society. This is an indication that gender could as well influence teacher`s usage of instructional materials in the teaching of mathematics as well as in students` learning of mathematics. Meremikwu et al., (2012) found that gender influences students learning with respect to the usage of instructional materials. Lee and Mahmoudi-Gahrouei (2020) revealed in their study that gender influences the usage of instructional materials in the process of teaching and learning. However, Alabere (2017) reported no gender difference with respect to teaching with instructional materials. The foregoing is an indication that researchers have no consensus with respect to the extent to which instructional materials facilitate teaching and learning based on gender. These disparities in reports from previous studies necessitated further research. Hence, the present study investigated the efficacy of instructional materials in enhancing the teaching and learning of mathematics.

METHOD

Design and Participants

This study was guided by a descriptive research design with structured questionnaire. The study was carried out in public secondary schools in Rivers state, Nigeria using 250 mathematics teachers and 400 at Junior Secondary Schools Year Three (JSS III) students. The study participants comprised of 650 mathematics teachers and students made up of 250 teachers (n = 125 males and n = 125 females), and 400 students (n = 200 males and n = 200 females) drawn through multistage sampling procedure involving simple random sampling (balloting with replacement) and stratified disproportionate sampling technique was drawn and used for the study. The participants were asked to complete the questionnaires after classroom teaching and learning. This was done to determine how regular mathematics is taught in the classroom using instructional materials. All participants who responded to the questionnaires filled and signed the informed consent forms. The instruments for the study were administered to participants using direct delivery technique (DDT) to ensure 100% return rate. We explained the research process to participants. We also informed participants that if they had any questions during the course of the study, they could ask questions. The demographic characteristics of the participants are detailed in Figure 12.

Measurement

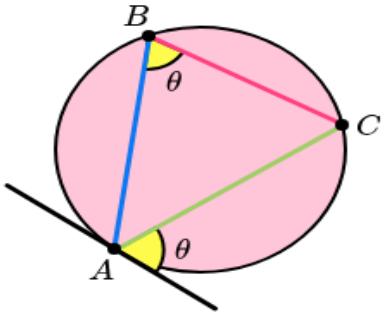
Two instruments; Instructional Materials for Enhancing Teaching of Mathematics Questionnaire (IMETMQ) for teachers and Instructional Materials for Enhancing Learning of Mathematics Questionnaire (IMELMQ) for students were used for data collection. Both instruments comprised 14 items each with 4-point response options from very high extent to very low extent. The

instruments were validated by experts in Mathematics, and Test and Measurement. The experts validated the instruments in terms of clarity of language, appropriateness and adequacy of the items in measuring what they were supposed to measure. The reliability indices of the instruments were determined by administering the instruments to twenty (20) mathematics teachers and fifty (50) students who were not part of the study but shared similar characteristics with the study population using the Cronbach alpha method to be 0.87 and 0.82 respectively.

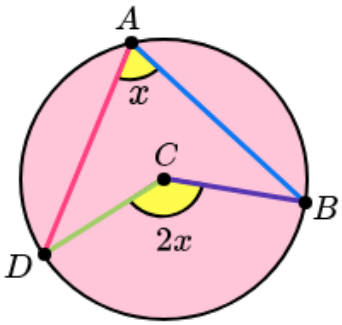
Procedure

The intervention was conducted in government secondary schools for two weeks. The JSS III students were taught geometry in mathematics by their regular class teachers using instructional materials. The content scope covered circle geometry. The content scope specifically consisted:

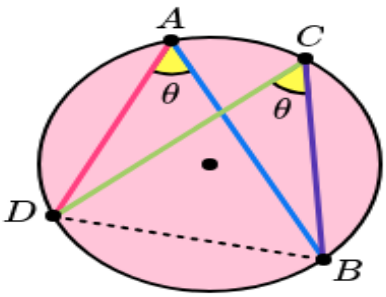
The alternate segment



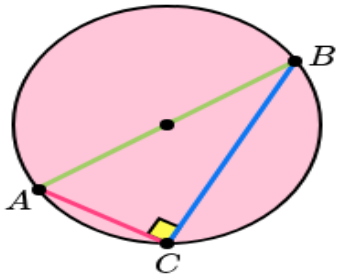
Angles at the center and at the circumference of a circle



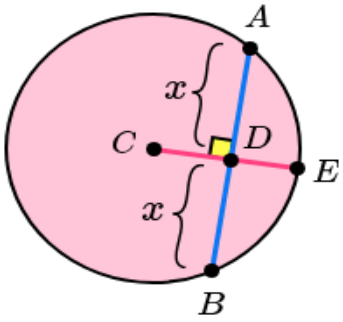
Angles in the same segment of a circle



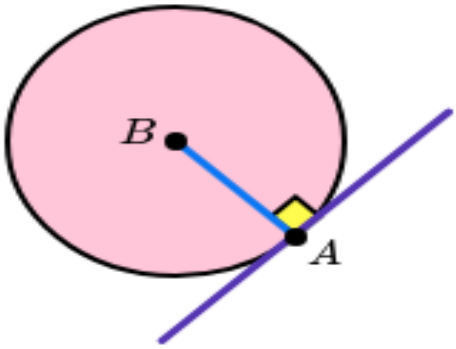
Angles in a semicircle

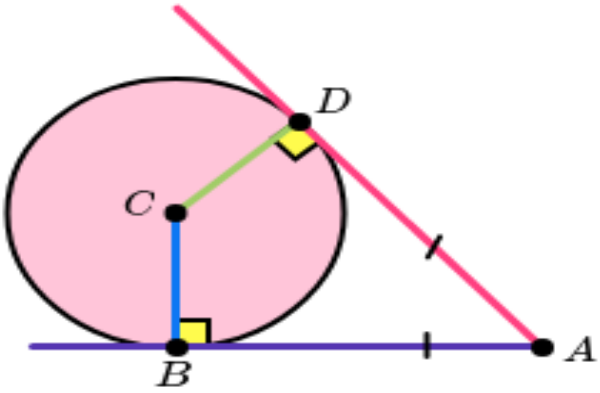


Chord of a circle

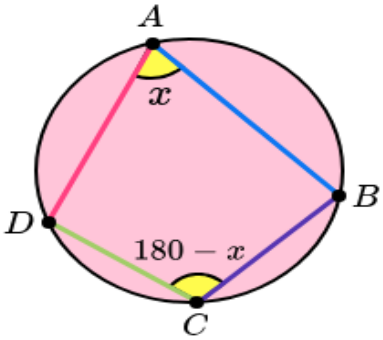


Tangent of a circle

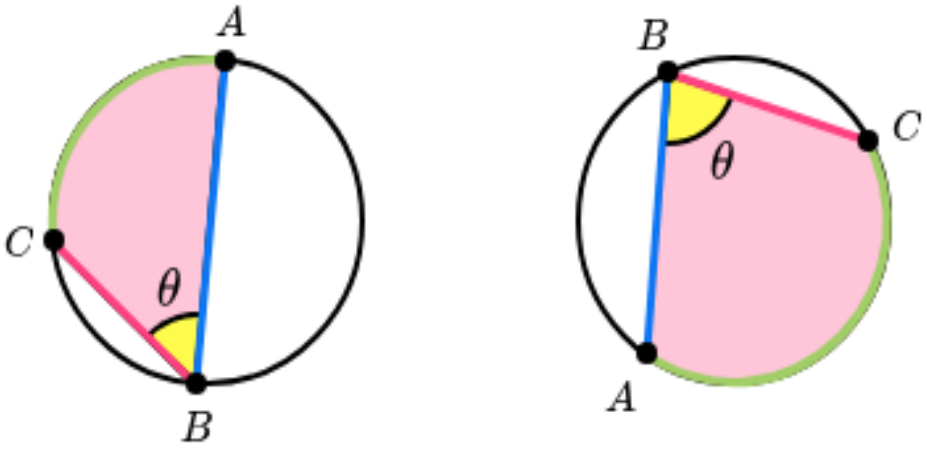




Cyclic Quadrilaterals



Substended angles



The classroom interaction was conducted using the school timetable and normal lesson periods. The duration for the lessons was 40 minutes each and strictly guided not to exceed the stated duration. Immediately after the classroom teaching and learning experiences, the researchers administered the instruments to teachers and students, who responded to the questionnaire, IMETMQ and IMELMQ respectively, to measure the efficacy of the instructional materials on students' academic performance. The completed instruments were collected from the subjects immediately for scoring.

The instructional materials were supported and enhanced by the mathematics teacher's oral presentation and explanations. The students were required to listen attentively, follow the instructions, as well as do all the assignments/exercises that followed the instructions. A pictorial presentation of classroom interactions is shown in Figure 11.

Figure 11. Students-teacher Classroom Interaction

Statistical methods

The data collected were subjected to analysis using SPSS version 23 involving Mean, standard deviation and t-test at 0.05 level of significance. The result obtained were presented using tables. Mean values of 2.50 and above were taken as high extent (HE), while mean values below 2.50 were considered as low extent.

Ethics statement

The ethics committee of the institution where the study was carried out granted ethical approval. Before the commencement of the study, the respondents were presented with informed consent forms to fill and sign. The informed consent forms were properly filled and signed. Also, the authors adhered to the ethical standard specification of the World Medical Association, 2013.

RESULTS

Participants

As can be seen in Figure 12, 37% of teachers have a bachelor's degree, 35% have a master's degree, and 28% have an academic doctorate. This demonstrates that despite a small percentage of the teachers who took part in the study completed their academic doctorates, the bulk of them had completed their first degrees. Also, 50% of the respondents are male, while 50% of the respondents are female, half of which are teachers and the other half students in each gender group. This indicates that the proportion of teachers and students who took part in the study was equal for both genders. Furthermore, the participants in the study are either Christians or Muslims only. 77% of the participants are Christians, while 23% of the participants are Muslims. This indicates that a greater proportion of the participants who took part in the study are Christians while no participant in the study was affiliated with other religious practices outside Christianity and Islam. Figure 1 also shows that, the participants in the study fall only in one of the major ethnic groups in Nigeria. 68% of the participants are Igbos, 17% of the participants are Yorubas, 15% of the participants are from the Hausa ethnic group, and none of the participants are from other minor ethnic groups. This indicates that a greater proportion of the participants who took part in the study are Igbos while the Hausas are the fewest. Overall, teachers and students share an equivalent proportion in the in the four demographic variables in the study.

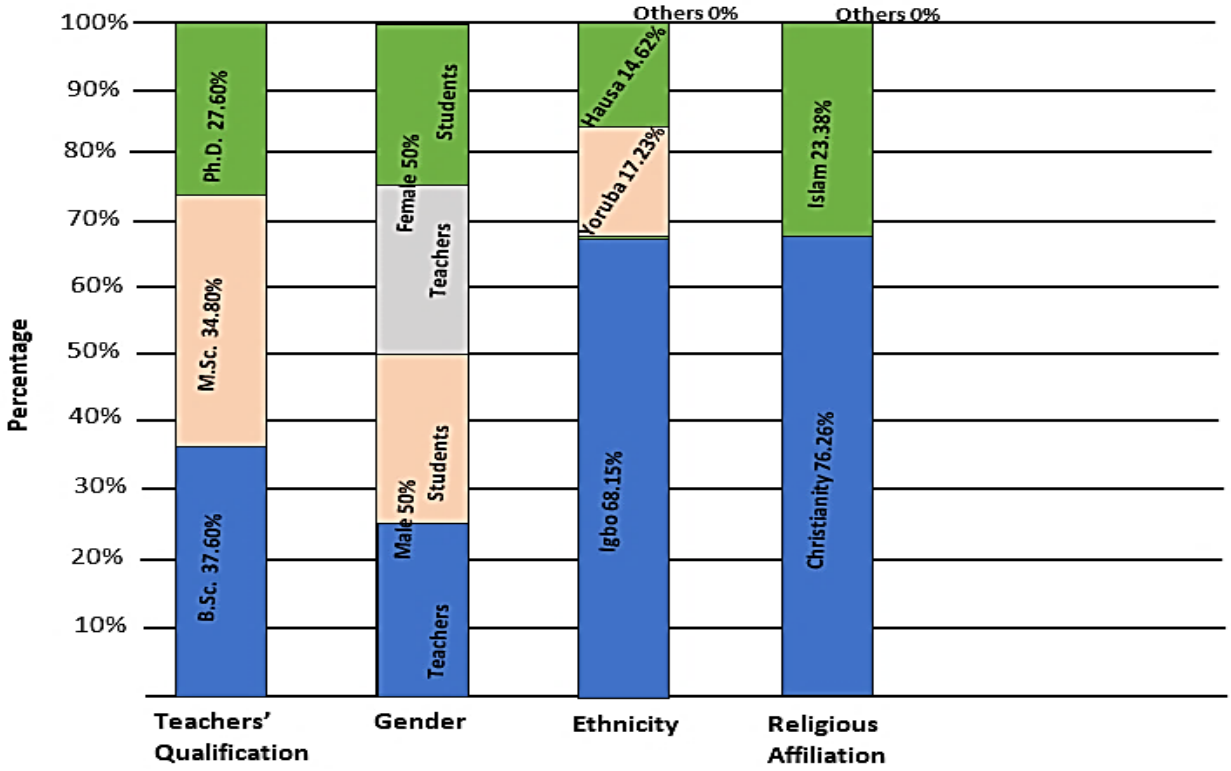


Figure 12. Demographic Characteristics of the Participants

Table 1 shows that all the items (1 to 14) have mean values above the criterion mean of 2.50. This is an indication that instructional materials enhance the teaching of mathematics to a high extent on all the items. The cluster mean value of 3.28 with standard deviation of 0.29 implies that the extent to which instructional materials enhances the teaching of mathematics is high.

Table 1: Extent to which instructional materials enhance teaching of Mathematics

S/No	Item Statement	$\bar{X}$	SD
1	Instructional materials enhance mathematics lessons planning and organization	3.31	.63
2	Instructional materials make it easy to present mathematics instructions sequentially from simple to complex	3.32	.46
3	Teaching aids enables students to understand mathematical concepts with ease.	3.31	.61
4	Use of instructional aids in teaching mathematics helps students to relate easily in the classroom	3.18	.74
5	Instructional materials enable the teacher to know the appropriate teaching method(s) to adopt when teaching mathematics	3.22	.66

6	Using instructional materials in teaching mathematics helps the teacher in identifying the tasks/activities that should be assigned to students	3.28	.65
7	Instructional materials help the teacher to easily and properly assess my students in a mathematics class	3.10	.69
8	Instructional materials enable the teacher to present abstract mathematical concepts in real life situation in the classroom	3.05	.72
9	Instructional materials make teaching of mathematics more interesting and appealing	3.29	.62
10	Instructional materials simplify difficult mathematical concepts	3.46	.57
11	Instructional materials help students concentrate/pay attention in mathematics class	3.27	.59
12	Instructional materials facilitate mathematics instructional delivery on time	3.36	.57
13	Teaching mathematics with the aid of instructional materials, enables the teacher to diagnose student's areas of difficulties.	3.29	.59
14	Instructional materials help the teacher to marry theory with practice whenever I am teaching mathematics.	3.42	.64
	Cluster Mean	**3.28**	**.29**

Key: HE = High Extent; LE= Low Extent.

The result of analysis in Table 2 reveals the mean and standard deviation on the extent to which instructional materials enhance the learning of mathematics as responded by students. The result shows that the mean values of 3.20, 3.26, 3.17, 3.00, 3.18, 3.20, 3.08, 3.01, 3.31, 3.36, 3.23, 3.33, 3.31, and 3.33 with standard deviations of 0.65, 0.52, 0.71, 0.75, 0.66, 0.63, 0.58, 0.69, 0.61, 0.60, 0.62, 0.56, 0.60, and 0.66 were respectively obtained for items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14. This implies that instructional materials enhance the learning of mathematics on all the items. The cluster mean value of 3.21 with a standard deviation of 0.31 is an indication that there is a high extent to which instructional materials enhance students` learning of mathematics.

Table 2: The extent to which instructional materials enhance learning of Mathematics

S/No	Item Statement	$\bar{X}$	SD
1	Learning of mathematics becomes interesting whenever there is an instructional aid	3.20	.65
2	The level of understanding of mathematics improves with the help of an appropriate instructional material	3.26	.52
3	Instructional materials motivate students to continue learning mathematics	3.17	.71

4	Abstract mathematical concepts can easily be comprehended when appropriate learning aids are used in teaching	3.00	.75
5	Instructional materials increase students` ability to think critically and creatively	3.18	.66
6	Instructional resources enable students to quickly represent concepts with real-life examples	3.20	.63
7	Students become focused to learn mathematics whenever there is a learning aid in the classroom	3.08	.58
8	Instructional materials simplify the learning of difficult mathematics concepts.	3.01	.69
9	With appropriate instructional aids, mathematics tasks can easily be completed by students	3.31	.61
10	Students use instructional materials for creating schema of mathematical concepts in long-term memory	3.36	.60
11	With the aid of instructional resources, students can logically present mathematical information in meaningful terms	3.23	.62
12	Instructional materials allow one to quickly and easily recalled mathematical concepts	3.33	.56
13	With the help of instructional aids, one can easily reorganize, create or build knowledge of mathematical concepts.	3.31	.60
14	Instructional materials increase self-efficacy when one is learning mathematics.	3.33	.66
	Cluster Mean	3.21	.31

Key: HE = High Extent; LE= Low Extent.

Table 3 shows the mean and standard deviation of the mean difference between male and female teachers on the extent to which instructional materials enhance the teaching of mathematics. The result showed that male teachers have a mean value of (n = 125, $\overline{X}$ = 3.46, SD = 0.27) while the female teachers have mean value of (n = 125, $\overline{X}$ = 3.09, SD = 0.18). This result means that both male and female teachers responded that there is a high extent to which instructional materials enhance the teaching of mathematics. However, the mean value of male teachers was higher than that of the female teachers. Further analysis shows that the t-vale of 13.971 obtained at 248 degrees of freedom has an associated exact probability value of 0.000. Since the probability value of 0.000 obtained is less than 0.05 level of significance set for decision, the null hypothesis was ejected. Inference drawn is that, there is a significant mean difference between male and female teachers on the extent to which instructional materials enhance teaching of mathematics.

Table 3: Influence of gender on the extent to which instructional materials enhance teaching of Mathematics

Gender	N	$\bar{X}$	SD	df	t-value	Sig.(2-tailed)	Decision
Male	125	3.46	.27	248	12.971	0.000	Sig.
Female	125	3.09	.18				

The result presented in Table 4 on the influence of gender on the extent to which instructional material enhance the learning of mathematics shows that the mean values of (n = 200, $\bar{X}$ = 3.40, SD = 0.29) was obtained for male students while (n = 200, $\bar{X}$ = 3.02, SD = 0.20) was obtained for female students. This implies that both male and female students reported a high extent to which instructional materials improves the learning of mathematics. Although, the mean value of male students (3.40) was found to be higher than that of the female students (3.02). Table 4 further indicated that the t-value of 15.533 obtained at 398 degrees of freedom shows an exact probability value of 0.000. This exact probability value of 0.000 obtained is less than the level of significance of 0.05, meaning that the null hypothesis was rejected. Therefore, it is concluded that the mean difference between male and female students on the extent to which instructional materials enhance the learning of mathematics is significant.

Table 4: Influence of gender on the extent to which instructional materials enhance learning of Mathematics

Gender	N	$\bar{X}$	SD	df	t-value	Sig. (2-tailed)	Decision
Male	200	3.40	.29	398	15.533	0.000	Sig.
Female	200	3.02	.20				

DISCUSSION

The use of instructional materials enhances the teaching of mathematics in public secondary schools to a high extent since the mean values to all the items and the cluster mean are above the decision mean of 2.50. This result is probable because, the usage of instructional materials provides teachers with the opportunity to simplify teaching, plan lessons and assesses students easily. The result of this study reinforces those of previous studies. The finding is consistent with the report of Crist (2014) as well as Effiong and Igiri (2015) who in their separate reports state that instructional materials help teachers in the process of planning instructions, its delivery and assessment of students.

The study also showed a significant difference in the mean values of male and female teachers on the extent to which instructional materials enhance the teaching of mathematics. This result means that the opinion of male and female teachers on the effectiveness of instructional materials on the teaching of mathematics is different. This result could be due to the fact that

gender influences peoples` actions as well as opinion. This could have made the responses of male teachers different from that of the females. The study of Lee and Mahmoudi-Gahrouei (2020) is supported by the result of this finding. However, Alabere (2017) disagreed with this finding. This disparity in findings may be due to such factors as location, qualification, teachers` perception, experience, among others.

Furthermore, the result of this study revealed that instructional materials enhance the learning of mathematics to a high extent as the mean values obtained are far above the benchmark mean of 2.50. This means that with instructional materials, students` can easily comprehend information as they can marry theory with practices, thus, leading to improvement in learning. This result revealed that with instructional materials, students` are able to easily concretize abstract concepts as well as store information using the learning aid as a schema. This finding is strengthened by the finding of Adalikwu and Iokpilgh (2013); Arope et al. (2014) and the study by Tety (2016) who in their different reports stated that instructional materials improve students` learning as it increases their understanding.

The result of this study further revealed that the difference in the mean values of male and female students on the extent to which instructional materials enhance the learning of mathematics is significant. This result implies that both male and female students have a different opinion on the extent of effectiveness of instructional materials on the learning of mathematics. This result is plausible since gender entails attitudinal and behavioural differences, this could have made the opinions of male and female students different. The result of Meremikwu et al. (2012) as well as Lee and Mahmoudi-Gahrouei (2020) are consistent with the finding of this study. However, Alabere (2017) reported a contrary finding. This differences in findings may be due to such students` factor as age, location, school types, among others.

IMPLICATIONS FOR MEASUREMENT AND EVALUATION TEACHING

Teaching and learning of educational measurement and evaluation for undergraduate students can be improved if measurement and evaluation practitioners can integrate instructional materials during instructional delivery in the classroom. The performance of undergraduate students offering measurement and evaluation course will be enhanced if measurement and evaluation lecturers employ instructional materials when delivering instruction. It was noted that instructional materials progressively improved teaching and learning in the present study. Therefore, practitioners should incorporate instructional materials in their teaching and learning process.

LIMITATIONS

It is pertinent to note that caution must be taken when drawing absolute conclusions based on the findings of this study for some reasons. The study data relied on questionnaire which are self-report instruments, capable of generating subjective response. Thus, findings of this study may be further verified using interviews, open-ended questions and focused group discussions. The sample

for this study involves mathematics teachers and students at secondary school education in Nigeria, therefore the results of this study can be therefore applied to mathematics teachers and students in Nigeria.

CONCLUSIONS

In line with the findings of the study, it is concluded that instructional materials are effective in improving teaching and learning of mathematics in public secondary schools. The extent to which instructional materials enhance the teaching and learning of mathematics is significantly different for male and female teachers; as well as male and female students respectively. Mathematics teachers should integrate instructional materials when teaching students. Students should understand that learning aids enhances their understanding, as such, they should intensify efforts towards using instructional resources to learn. Mathematics teachers teaching Students should make use of instructional materials during instructional delivery.

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