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# TEACHER TECH-CREATIVITY FOSTERING BEHAVIOUR AS DETERMINANT OF PRIMARY SCHOOL MATHEMATICS TEACHER CLASSROOM PRACTICES

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**Abstract**

This research investigated teacher technological-creative fostering behaviour as determinant of teacher classroom practices in private primary schools in the Makurdi Local Government Area, Benue State, Nigeria. This study adopted the correlational research design. The population was all teachers in private primary schools in Makurdi. A sample of 70 mathematics teachers was drawn from 50 private primary schools. Two researcher-structured instruments were used for data collection, namely; the Mathematics Teacher Tech-Creativity Inventory (MTTI) and the Mathematics Teacher Classroom Practice Inventory (MTCPI). Correlation, scatterplots, and histograms were used to answer research questions, while analysis of variance was used to test the hypotheses at .05 level of significance. The following were the findings: the top three technological tools among others which mathematics teachers at the primary school level use most often to facilitate their teaching practices are, first interactive whiteboard, second, the calculator and third, internet surfing. Teacher tech-creativity fostering behaviour has a significant impact on teacher clarity, teacher classroom discussions, teacher feedback, teacher formative assessment and, teacher-teacher collaboration as teacher classroom practices. It was recommended that teachers of mathematics consider utilizing technology creatively during lessons as a catalyst to advance classroom teaching practices of teacher classroom clarity, class discussions, teacher feedback, formative assessment, and teacher-teacher collaboration.

**Keywords:** Tech-creativity, teacher clarity, teacher feedback, teacher formative assessment, teacher-teacher collaboration.

## INTRODUCTION

With its innovations and advantages for producing and exchanging ideas and content, new technologies have quickly changed the way that teaching and learning are done. Therefore, it is important to think about the advancement and impact of learning technology in conjunction with chances for creative education rather than in isolation. Technology is used to distribute, interact with, or promote information. It encompasses electronic teaching (e-teaching) and electronic learning (e-learning). Increased access to teaching-learning possibilities, time and place convenience, a wider range of teaching and learning resources available, enhanced opportunities for individual learning, and the development of more cognitive tools are all benefits of e-teaching and e-learning (Ugwuogo, 2011).

Comparably, digital technology fosters connections, enriches student experiences, simulates scenarios, encourages collaboration, and generates engaging learning settings (UNESCO, 2023). In technologically advanced settings, teachers can employ digital tools and technologies to foster students' creative thinking (Henriksen, Mishra, & Fisser, 2016; Yalcinalp & Avci, 2019). By using technology in teaching and learning, educators can provide students with hands-on learning opportunities that sustain their interest in a subject without diverting focus from it (Haleem, Javaid, Qadri, & Suman, 2022). By assigning assignments that use technologically-based resources like computers, projectors, and other state-of-the-art technological tools, teachers can make their students' learning more dynamic and engaging. This could make their classes incredibly fascinating and interesting for the students (Lopez-Fernandez, 2021).

Teachers of mathematics may at some point face challenges while trying to plan lessons on difficult mathematics concepts, solve difficult mathematics problems, or try to incorporate techniques to make mathematics teaching-learning processes simplistic and modify their teaching practices. If this becomes a dilemma, blending technology and teacher creativity may more or less become essential to benefit the teaching-learning process. The innovativeness and ingenuity that comes with creative thinking and technology in the classroom strengthen and thicken the teacher's expertise and favors excellence in the teaching profession.

**Theoretical background of the research**

Generally in this work, the theoretical underpins of tech-creativity and teacher classroom practices are borne from the premises of models such as the technological pedagogical content knowledge (TPACK) model (Mishra & Koehler, 2006), Substitution, Augmentation, Modification, Redefinition (SAMR) model (Puentedura, 2006), feedback model (Hattie & Timperley, 2007), and on theories of socio-constructivist theory by Vygotsky (1978), formative assessment theory (Black & Williams, 1998) and the cognitive load theory (Sweller, 1988).

The TPACK model is a framework developed to address the complex interplay of technological knowledge, pedagogical knowledge, and content knowledge required for effective teaching with technology (Mishra & Koehler, 2006). The model has helped educators to integrate technology into their teaching practices. Consequently, the SAMR model was designed to help educators integrate technology into teaching and learning (Puentedura, 2006). Also, the feedback model was developed to emphasize the importance of feedback in enhancing students' learning and teacher instructions (Hattie & Timperley, 2007).

The theory of socio-constructivism emphasizes that knowledge is actively constructed or developed through social interactions and collaborations with others, which fosters a learning environment where joint activities, discussions, and problem-solving tasks are emphasized (Vygotsky, 1978). Also, the cognitive load theory is an educational theory that focuses on the mental effort involved in learning, and how the cognitive resources of learners are assigned, and it proposes strategies to manage cognitive load effectively for maximum learning outcomes to be achieved (Sweller, 1988). Furthermore, the theory of formative assessment highlights the importance of ongoing classroom-based assessments to enhance students' learning. The theory emphasizes the pivotal role of feedback, questioning, and self-assessment in formative assessment practices, thus promoting the idea that if such methods are employed, teaching, and learning outcomes will be improved (Black & Williams, 1998).

These aforementioned models and theories form the basis for which classroom practices of teacher clarity, class discussions, teacher feedback, formative assessment, and teacher-teacher collaboration are intertwined with teacher tech-creativity to revolutionize the classroom scenario. Teacher clarity is an essential element of effective teaching (Brckalorenz, Cole, Kinzie, & Ribera (2012). Teacher clarity draws on the sync of cognitive load theory and technology integration models such as the SAMR. Teacher clarity is aligned with the extraneous cognitive load which exposes that where additional mental effort imposed by instructional design or presentation of information is poorly designed or where unclear instruction is given, this can contribute to extraneous load (Benton & Li, 2021). With technology integration, the teacher can modify and redesign tasks to enhance new possibilities and capabilities. Therefore, the interface between tech-creativity and teacher clarity involves the teacher utilizing technology creatively to redesign and modify learning experiences to enhance clarity in conveying information, fostering engagement, and providing meaningful learning experiences.

The theoretical framework for tech-creativity and class discussion incorporates Vygotsky's theory of socio-constructivism which highlights the importance of social interaction and collaborative learning. In this framework, teachers are encouraged to use technology to augment students' interactions and discussions in class. This can be done by employing online platforms, discussion forums, or using collaborative tools to extend class discourse beyond conventional classroom boundaries. The TPACK may be significant in emphasizing the interaction of technological skills, pedagogical knowledge, and subject matter expertise. Incorporating technology creatively can enhance the quality of active participation, class discussions, critical thinking, and meaningful dialogue among students (Sharma, 2023; Eiland & Todd, 2019).

Consequently, the theoretical framework of tech-creativity and teacher feedback is founded on the TPACK model, cognitive load theory, and feedback model. It underpins the importance of using technology creatively to facilitate effective feedback mechanisms in the learning process (Deeley, 2018). The framework explores how tools and platforms can be employed to provide timely and personalized feedback. Cognitive load theory guides the design of technology-enhanced feedback that aligns with students' cognitive capacities while promoting comprehension and retention. The theory of cognitive load contends that learning is prevented when the brain experiences cognitive overload. By enabling pupils to concentrate on the intended instruction, technology can help lessen cognitive overload. Students can use the time saved to study, practice, and get feedback on materials they have learned. In all, the framework encourages teachers should creatively integrate technology in class to improve the quality and efficiency of feedback which can foster students' learning and teacher instructions.

In the same vein, tech-creativity and formative assessment incorporate technological tools and formative assessment theories. It emphasizes the integration of technology to enhance the formative assessment process, which involves gathering information during instruction to inform teaching and improve learning (Deeley, 2018). The framework encourages teachers to employ a variety of tech-based formative assessment strategies such as quizzes, interactive simulation, and instructional feedback tools to tailor instructions and support students' learning. Finally, tech-creativity and teacher-teacher collaboration are founded on socio-constructivist theory of Vygotsky and the technology integration model such as TPACK. Given that Vygotsky's theory places a strong emphasis on social contact and teamwork in the learning process, the framework for teacher-teacher collaboration encourages educators to use technology in innovative ways to promote communication, resource/material sharing, and cooperative lesson planning (Cicconi, 2013). Teachers may interact electronically, discuss creative teaching techniques, and participate in continuous professional development using technology.

**Literature review**

In this paper pertinent concepts like teacher creativity, technology conceptualization, tech-creativity, and teacher classroom practice are explained for better understanding.

The collection of abilities known as *creativity* is what makes ideas clever, worthwhile, and concise. The ability to effect change and transition from one outdated paradigm to a more modern one while achieving learning objectives is a component of teacher creativity, a word that is frequently used both within and outside of the classroom (Darma, Notosudjono, & Herfina, 2021). To help students develop a variety of skills, including social, emotional, and cognitive skills, teachers must be creative in their approach to teaching. This involves using innovative approaches and responding nimbly to novel situations. Ultimately, this helps make learning more engaging and effective (Lapeniene & Dumciene, 2014; Rankin & Brown, 2016).

In most conceptualizations, teacher creativity also encompasses teaching for creativity, that is enabling students to become creative themselves (Lapeniene & Dumciene, 2014). For something to be the product

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of a creative process, it is not enough for it to be novel, it must have value or be appropriate to the cognitive demands of the situation. A creative mind is an innovative mind prepared to bring about solutions to identified challenges or hitches faced when such challenges are identified. (Gyuse, Achor, & Chianson, 2014).

The imaginable cannot suppress creativity because it can generate ideas and solutions that transcend both reason and the conceivable. Ideas that are qualitatively distinct and not tangibly attributable to any one preceding notion can be produced by creativity (Rott & Liljedahl, 2018).

Agogo (2018) avers that the ultimate aim of creativity is the production of responses, ideas or products that are novel, original, and uncommon. In the same vein, Ortese, Yawe, and Akume (2014) define creativity in a different way, which is the ability to see problems in a new way and the ability to escape the bonds of conventional thinking. Creativity is a cognitive activity that is based on human thinking which leads to new, original, and useful ideas and products. By implication, creativity celebrates ingenuity and hard work that yields positive results. This has become so relevant now that Benjamin Bloom and his students (Anderson, Krathwohl, & Bloom, 2001) have modified Bloom's taxonomy of educational objectives; in an earlier version, evaluation was placed as the higher-level of thinking but it has now been replaced with creating as the highest-level of thinking (Achor, 2020). This makes it evident that creativity is a fundamental skill necessary for knowledge formation.

Numerous factors can impact a teacher's creativity, such as their prior work experience in the classroom, their history of interacting with students, the use of various learning environments, tools, and techniques, and their ability to collaborate with other educators and school administrators (Oroujlou & Vahedi, 2011; Blazar & Kraft, 2017). By creating and implementing innovative teaching methods, mediating—using their expertise to interpret and seek support on various improvement plans—and cultivating strong bonds with other educators, teachers can bring creativity into the classroom and support learning by helping students grow and change through the reciprocity of the teaching-learning process. When teaching methods incorporate creativity, the classroom becomes more of a breeding ground for creative and effective instruction. Imagination flourishes when it is encouraged. Creativity displayed by a teacher depicts a person's competence as an ideal teacher. Teaching with creative expressions, guiding students with creative approaches and methods, and as well giving students opportunities through instructions to develop their ideas that can break impending barriers and achieve ideas due to thinking 'out of the box', serves as a positive pathway to enhancing class lesson productivity and students' knowledge.

*Technology* is the practical application of knowledge so that something entirely new can be done, or so that something can be done in a completely new way (European Space Agency, 2023). This implies that technology can afford teachers of mathematics the opportunity to revamp their knowledge, skills, and teaching practices when the need arises. Technology has been integrated into some traditional teaching methods and class instructions to foster more engaging and exciting learning experiences. For instance, students now enjoy e-scaffolding, e-simulation, and more. Technology integration is the effective implementation of educational technology to accomplish intended learning outcomes (Achor, 2022). Teachers of mathematics now have a myriad of options via technology at their disposal to select, tryout, and approve the appropriate instructional methods and strategies to utilize in class, which may help to improve their teaching.

The term *tech-creativity* is a derivation from technological creativity. According to Sierotowicz (2015) technological creativity is highly fostered in "knowledge-creating" organizations for innovation of new products, new processes, and services. Creativity can be viewed as the ability to bring in new ideas, while technology encapsulates useful innovations. Hence, tech-creativity can be defined as the ability to come up with new ideas whose consequence is the development of useful innovations. Tech-creativity can be seen as using novel idea-driven applications from the exploitation of creative inventions or innovations in pursuit of solving societal and classroom problems (Rambe, Ndofirepi, & Dzansi, 2016). Technology use in the classroom is exceptional then when blended with creativity, lessons become enriched. Enriched in the sense that in the classroom, technological impact has increased interactivity and class engagement. It can foster better overall comprehension, practical learning, time management, and combined learning methodologies (Bay Atlantic University, 2022).

The greatest applications of educational technology, according to Mishra, Koehler, and Henriksen (2011), must be based on innovative mindsets that value taking intellectual risks and being open to new ideas. Any teacher, but especially novice instructors, has a great struggle with this. Technology has altered the way educators find material to use in their classes, organize it, and incorporate it. This may affect their methods of instruction, raising the bar for professionalism. Teachers must make decisions about what and when to use digital technology in their lessons more frequently as a result of the expanding role and availability of this technology in society (Gonscherowski & Rott, 2022). Most likely, this is an attempt to make lessons more interesting and captivating.

The rapidly evolving landscape of teaching and learning necessitates that educators become more adaptive and take a creative approach to the digitally advanced classroom. Teachers must thus stay up to date on the use of technology and creativity in the classroom; nonetheless, the effectiveness of their efforts depends on how they represent tech-creativity. Teachers of mathematics who are technologically creative should be able to assess themselves based on a few of the following statements but not restrictively: 'I enjoy trying out new mathematical ideas using technologically-driven tools in class,' 'I am willing to try any new technology supported method even if there is a chance it could fail,' 'I love to modify and adapt mathematics lesson routines in line with new technology', 'I am continually looking for new technology-driven ideas to make the teaching of mathematics easier', 'Once I have developed a technology supported plan, I am prepared to use it during mathematics lessons', and lastly 'I continuously look at old problems with a fresh mindset guided by latest technology developments during mathematics lessons'. The aforementioned development may tend to force teachers to independently decide and construct their reality within the context of their personal and work environment. It is in the process of personal learning and development that teacher creativity using technology becomes a necessary means to evolve teacher classroom practices and thereby imparting knowledge to the students.

*Teacher classroom practices* range from designing learning experiences for the students, selecting instructional materials, developing lesson objectives, presentation of the lesson, and managing students' behaviours (Cornelius-Ukpepi & Aglazor, 2019). For this work, some suggested highly effective teaching practices by Alber (2015) were investigated for effective teaching of Mathematics in this study. Understanding how teachers use classroom instruction to engage students, how they adapt their teaching and interaction strategies, how confident they are in communicating expectations to students, whether or not they use classroom discussion as a learning tool, and how well their formative assessment and feedback strategies are enhancing the learning environment are all crucial to improving the mathematical achievement culture of teachers.

Alber (2015) further identified certain variables that are encapsulated in classroom teaching practices which may likely be enhanced via teacher tech-creativity, the variables selected are: 1) teacher clarity; 2) classroom discussion; 3) feedback; 4) formative assessment; 5) teacher-teacher collaboration.

Though these practices are recurring teacher events in the classroom, their viability will necessarily depend on how the teacher can reinforce novel ideas to keep them enlightening. The novelty in idea formation here brings about creativity. These variables are discussed based on their possible relatedness to teacher creativity.

The idea of "clear teaching behavior," which, according to Hattie (2012), outlines the abilities, information, attitudes, and values that students must acquire, is crucial to the idea of teacher clarity. When a teacher introduces a new subject to the class, it is best to explain the purpose and learning objectives. Then, the teacher can use creative and explicit visual aids to help students understand difficult concepts, and online resources like interactive whiteboards, educational apps, and video tutorials can help students learn more engagingly. Connecting and sharing resources via social media platforms facilitates learning about the most effective teaching methods for pupils. For pupils to see what the finished result looks like, it is best to additionally show them models or examples.

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Classroom discussion can help students acquire better communication skills, as they learn to present ideas clearly and briefly; it also provides opportunities to practice listening skills and follow what others are saying (Cashin, 2011; Kosko, 2012). Teachers need to frequently initiate and facilitate entire class discussions with the view of allowing students to learn from each other. It is also a great opportunity for teachers to formatively assess (through observation) how well students comprehend the new content and concepts. Teachers can creatively foster class discussions by using open-ended questions that allow students to think critically, and develop new ideas and opinions. Incorporate multimedia to spark discussions and help students visualize concepts and ideas that will cause discussions to be more interactive. Teachers can use reflective questions and give students room to process, and engage students in discussions that can help them express themselves creatively.

Consistent feedback gives students a better understanding of their progress. Teachers should give whole-group feedback on areas of need and patterns they observe in the growth of the classes as a whole in addition to written or verbal input to individuals. For the teacher to modify the teaching strategy, resources, and guidelines as necessary, students must also be given the chance to offer feedback (Zhang & Zheng, 2018). According to Jimin, Chianson-Akaa, and Amua (2023), one environmental element that affects students' self-efficacy is the feedback they receive from their teachers. Feedback has the potential to steer classroom conversations. Teachers who are providing innovative feedback can also urge students to reflect on their work and identify areas that require improvement. This approach empowers students to take responsibility for their learning. Using peer feedback is another way of creatively giving out feedback, students should be allowed to provide feedback to their peers which will help them develop critical thinking skills and further improve communication. Using technology such as online quizzes, surveys, or interactive whiteboards, is another way to make feedback creative and more engaging. Using visual aids such as graphs, charts or diagrams helps students to track and understand their progress better, then identify areas they need improvement.

Formative assessment is described as a process in which students participate in the process through self-assessment, teachers adapt their instruction based on assessment evidence, and students receive feedback on their learning and suggestions for improvement (Black & Wiliam, 2009). Teachers must regularly and often evaluate their student's progress toward the topic's learning objectives or final result to give them insightful and correct feedback (summative evaluation). Students will find formative assessment enjoyable and less threatening if teachers use creative approaches such as: requesting students to mention subjects or topics they find hard to understand and then providing a specific worksheet or journal to students to express their thoughts. Asking class representatives to evaluate the performances of their classmates. Asking students to self-evaluate their learning growth and performances. Teachers can try to be creative in giving formative assessment by asking students to write a letter to a family member or friend on a sheet of paper or index card, explaining to them a new concept they have learned.

A strong collaborative culture among teachers is one element that is widely accepted to support improvements in classroom and school environments. According to Richter and Pant (2016) and Kolleck, Schuster, Hartmann, and Grasel (2021), teachers are expected to work in teacher teams, collaborate closely with colleagues, and co-construct classroom methods to build trust connections within the team. Although it does not appear frequent, teacher collaboration has a lot to offer those who participate. In addition to providing instructors with the chance to exchange sound ideas and dispel misconceptions based on newly acquired knowledge, teacher collaboration with colleagues is crucial for the development of a professional community. Teaching can be exhausting and emotionally draining. Teachers face stress in their profession, whether it is from managing a particularly difficult student or juggling work and home life (or both). Fortunately, their colleagues may offer assistance during stressful times.

Teachers who rely on one another for help, can build relationships based on empathy and trust. Establishing enduring professional and mentoring ties requires these frequent encounters. Supported teachers are more likely to give their students the same support (Arkansas State University, 2020). When educators learn to work together electronically in real-time or offline to discuss issues, advancements, and new advances, they can collaborate creatively. Teachers can also form collaboration teams and build productive relationships that can rid them of archaic and mundane approaches, skills, and practices. Another creative way to handle teacher-teacher collaboration is by encouraging peer observations; teachers can learn from each other when they observe each other teach and also provide feedback on what they have observed. Yet another creative way of handling teacher-teacher collaboration is by introducing professional learning communities; these are groups of educationists who meet regularly to discuss teaching practices, students' learning, and other topics related to education. Some research works focused on creativity and technology used to enhance teacher's performance or students' learning. For instance, the findings of Fitriah (2018) revealed that teachers are aware of the importance of technology in creativity. Technology appears to help them explore their creativity and encourages learners' creativity as well such that it helps transfer their creativity into reality, making the activities more authentic, and provides teaching materials on various topics. Similarly, Mgboro, Otuba, and Uda (2019) looked into how to use digital technology to increase teacher creativity and discovered that the social environment in which teachers work, external institutional forces, and internal creative personality traits all contribute to increased teacher creativity. In other words, using digital technology in secondary school instruction enables instructors to participate in the learning process. However, the sustainability of this type of teacher involvement depends on the presence of creative personality qualities and an environment that fosters creativity. Additionally, research by Li, Kim, and Palker (2022) showed that new technologies efficiently foster students' creativity, especially in interactive learning environments.

Mathematics teachers can construct everyday creativity through the implementation of technology to improve their teaching practices. Technology does not provide ideas; technology can complement skills by providing a means of experimentation and exploration (Carlile & Jordan, 2012). Teachers who have not equipped and improved their tech-creativity skills may not be apt with the required and essential teaching practices, this can further hamper students' performance in mathematics.

Technology and creativity complement each other because technology applies practical ideas for the emergence of something new. For a new thing, idea, concept, or method to be initiated and actualized, creative thinking must be involved. Hence, teachers of mathematics must consider harmonizing technology and creativity in the teaching and learning process. Teacher classroom practices are teaching culture operations in which teachers need to steer teaching and learning procedures in the classroom. Teachers of mathematics may necessarily need to upgrade, alternate, and sometimes vary the approaches they employ while delivering classroom practices. It is possible to go about this action fervently if teachers are abreast with recent relevant technological applications blended with creative thinking to enhance the smooth sailing of the teaching-learning process. Technological facilities provide the opening for teachers to select from numerous options what technological innovations are suitable for use to advance their teacher classroom practices and keep teachers well-informed about innovations in classroom practices. The essence of being tech-savvy for knowledge growth and the development of professional skills cannot be over-emphasized. This knowledge becomes eminent and necessary to sustain the teachers' quest and zeal to enhance professional development and as well make their classroom practices prosper.

**Statement of the problem**

Mathematics teachers may need to re-evaluate how they present their teaching instructions to erase doubts or fears of futile or unworkable classroom practices. Teachers may need to see if infusing creativity into lesson delivery can foster teaching practices. Teachers may also be worried if the way knowledge is transferred from teacher to student is adequate or appreciable. Teachers worry if students comprehend what they teach and how they go about the teaching, which is especially true for beginning teachers of mathematics. Mathematics teachers worry about these issues and more because of the existing poor students' performance in mathematics, which may likely be attributed to how teachers impart knowledge during the teaching-learning process. The growing ambivalence in the minds of mathematics teachers due to thoughts of their underperformance and students' poor performance has caused teachers to lose their courage and relegate their classroom teaching practices.

Mathematics teachers may gloss over classroom teaching practices, considering them superficial. The truth is that these practices make or break the teaching and learning scenario in the classroom. Without acquiring the ethics of classroom teaching practices, teachers are half-baked and cannot be recognized as fit for the responsibility of teaching. Some teachers may have adopted the right practices, but without infusing technology and creativity into their teaching, which may have crippled the ingenuity, ferventness, and effectiveness of their teaching. With technological advancement which has exploded and gained ground in our school and classroom systems, it is unfair and illogical for teachers to imbibe teaching practices without blending them with tech-creativity. Teachers may need to try tech-creativity to see if it can foster their classroom teaching practices to redeem their lost courage and teaching expertise. This justifies the worry for this study.

**Research questions**

The following research questions (a derivative of Alber's criteria) were answered in this study:

1. What types of technological tools are available for use to enhance teacher classroom practice?
2. To what extent does teacher tech-creativity foster behaviour affect teacher clarity in class as a teacher classroom practice?
3. To what extent does teacher tech-creativity foster behaviour affect teacher class discussions as a teacher classroom practice?
4. To what extent does teacher tech-creativity foster behaviour affect teacher feedback as a teacher classroom practice?
5. To what extent does teacher tech-creativity foster behaviour affect teacher formative assessment as a teacher classroom practice?
6. To what extent does teacher tech-creativity foster behaviour affect teacher-teacher collaboration as a teacher classroom practice?

**Hypotheses**

The following hypotheses were tested at .05 level of significance:

Ho1: Teacher tech-creativity fostering behaviour has no significant impact on teacher clarity as a teacher classroom practice.

Ho2: Teacher tech-creativity fostering behaviour has no significant impact on teacher classroom discussion as a teacher classroom practice.

Ho3: Teacher tech-creativity fostering behaviour has no significant impact on teacher feedback as a teacher classroom practice.

Ho4: Teacher tech-creativity fostering behaviour has no significant impact on teacher formative assessment as a teacher classroom practice.

Ho5: Teacher tech-creativity fostering behaviour has no significant impact on teacher-teacher collaboration as a teacher classroom practice.

## METHOD

The research design used in this study was correlational, which evaluates the relationship between the predictor and the criterion variable. With little to no attempt to control unrelated variables, correlational research is a sort of nonexperimental study in which two variables are measured and the statistical relationship—that is, the correlation—between them is evaluated (Jhangiani, Chiang, Cuttler, & Leighton, 2020). The criterion variable was teacher classroom practices, and the predictor was teacher tech-creativity. The Makurdi Local Government Area in Benue State, Nigeria, is the research area. All of the private primary school instructors in the Makurdi local government area make up the study's population. In Makurdi Local Government Area, fifty private elementary schools provided a sample of seventy mathematics teachers. Schools were drawn using a systematic sampling procedure. Private

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schools were used because they are mostly equipped with technologically driven facilities to aid and facilitate teaching and learning.

Two structured instruments developed by the researchers were used for data collection namely: The Mathematics Teacher Tech-Creativity Inventory (MTTI) was an adopted and modified version of the instrument by Rambe, Ndofirepi, and Dzansi (2016), and the Mathematics Teacher Classroom Practice Inventory (MTCPI) was developed by the researchers. The MTTI has three components; firstly, the biodata section; secondly, a selected list of technological tools used by mathematics teachers, such as desktops, calculators, internet surfing, and laptops, and the freedom for teachers to include any other tools they have used; lastly, twelve item statements on teachers' level of creativity. These statements come with four options ranging strongly agree (SA-4), agree (A-3), disagree (D-2), strongly disagree (SD-1). A few of the draft items for MTTI are: "I enjoy trying out new mathematical ideas using technologically driven tools in class," "I am willing to try any new technology-supported method even if there is a chance it could fail," and lastly, "I continuously look at old problems with a fresh mindset guided by latest technology developments during mathematics lessons." The MTCPI is an instrument with 25 items, which cover the five components of teacher clarity, teacher discussion, teacher feedback, formative assessment, and teacher-teacher collaboration with four options ranging from always (A-4), sometimes (S-3), rarely (R-2), never (N-1). It has two sections, the first is the biodata section, and the second section covers components of teacher classroom practices such as teacher clarity, teacher discussion, teacher feedback, formative assessment, and teacher-teacher collaboration. A few selected items from components of the MTCPI are: "give vivid explanations to students who lack the requisite knowledge," "relate the lesson to students to have their opinions," "call students privately to discuss areas of weakness and strengths," "give assignments after each lesson to assess knowledge yet uncovered," "take a cue from other teacher's lesson plans for deeper understanding." Both MTTI and MTCPI were trial-tested to establish their reliability coefficients which were obtained as .82 and .75 respectively. The instruments were given out to three experts to ascertain face validity. Schools selected for the study were visited, permission was sought from various school Head- teachers then, the instruments were administered to the teachers. Correlation and histograms were used to answer the research questions while analysis of variance was used as inferential statistics to test the hypotheses at .05 level of significance.

## RESULTS

**Research Question 1**

What types of technological tools are available for use to enhance teacher classroom practice?

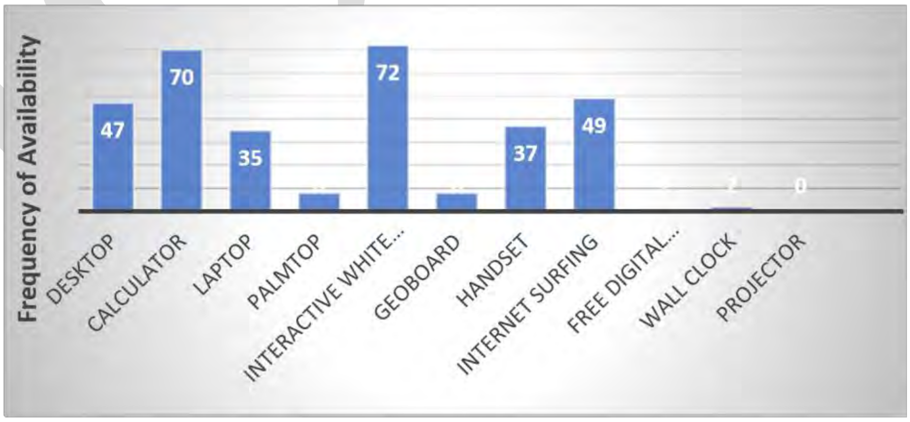


**Figure 1.** Technological tools that foster teacher classroom practices.

Figure 1 shows technological tools listed by the researchers and others included by mathematics teachers. From Figure 1, the top three technological tools among others that mathematics teachers at the primary school level use most often to facilitate their teaching practices are, first interactive

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whiteboard, second, the calculator, and third, internet surfing. Projectors and wall clocks are hardly used.

**Research Question 2**

To what extent does teacher tech-creativity foster behaviour affect teacher clarity as a teacher classroom practice?

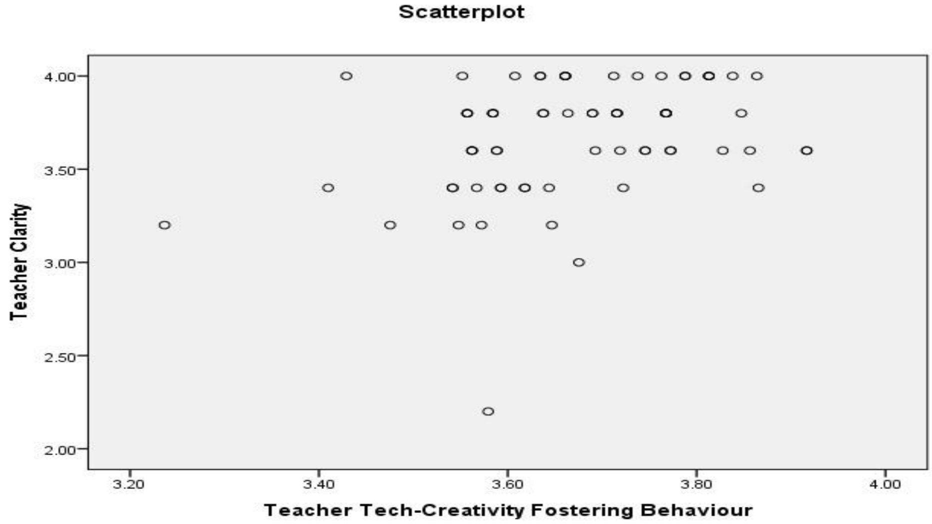


**Figure 2.** Scatterplot for teacher-tech creativity and teacher clarity.

Results from the scatterplot on Figure 2 show a low positive correlation in the responses between teacher-tech creativity and teacher clarity as a teacher classroom practice.

**Table 1.** Correlation analysis of teacher tech-creativity on teacher clarity.

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .394[a] | .156 | .143 | .29210 |

a. Predictors : (Constant), MTTI
b. Dependent Variable : Teacher Clarity
c. R-Squared : .156

**Histogram**
**Dependent Variable:** Teacher Clarity

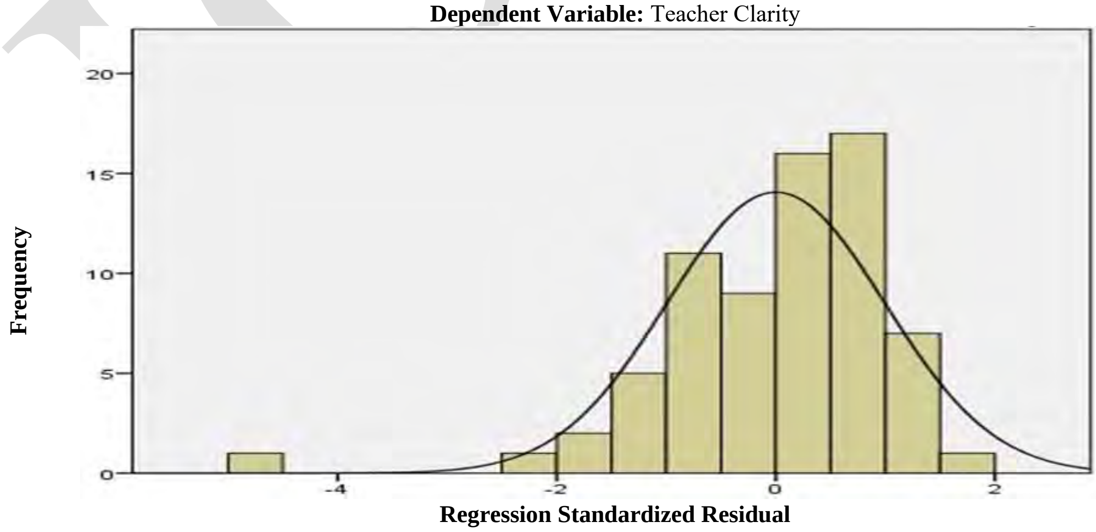


**Figure 3**. Histogram illustrating regression of teacher tech-creativity against teacher clarity.

From Table 1, the results have shown that there is a positive moderate relationship (R= .394) between teacher tech-creativity and teacher clarity as a classroom teaching practice. This means that a single increase in the value of teacher tech-creativity causes a relative increase in the value of teacher clarity in the same direction. Table 1 further shows that 15.6% of the variation in teacher clarity is accounted for by teacher tech-creativity. The histogram on Figure 3, further shows that the distribution is negatively skewed to the left, meaning that the mean value is less than the median value.

**Research Question 3**

To what extent does teacher tech-creativity foster behaviour affect teacher class discussions as a teacher classroom practice?

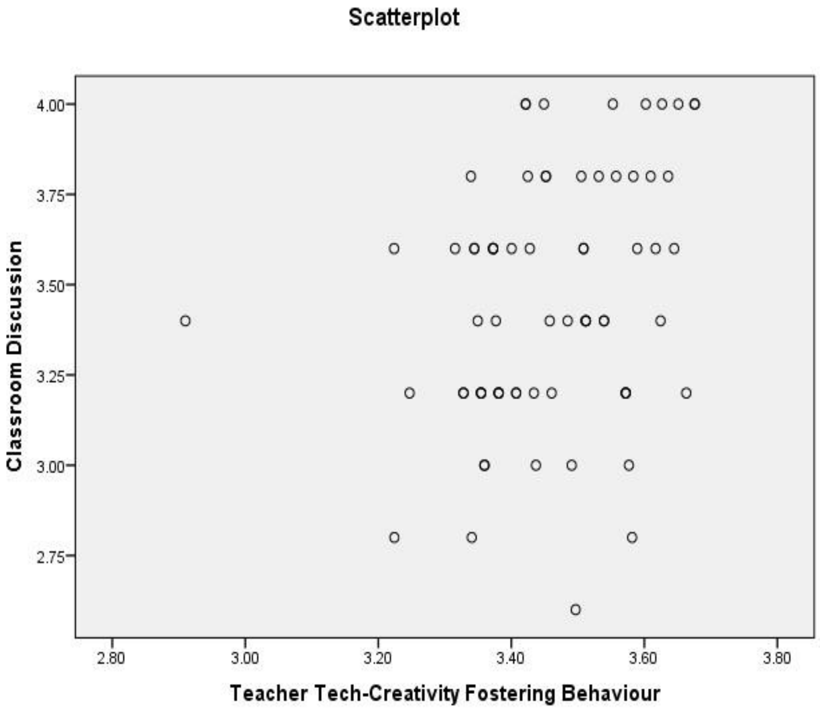


**Figure 4.** Scatterplot for teacher-tech creativity and teacher class discussions.

Results from the scatterplot on Figure 4 show a low positive correlation in the responses between teacher-tech creativity and teacher class discussions as a teacher classroom practice.

**Table 2**. Correlation analysis of teacher tech-creativity on teacher class discussions

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .370[a] | .137 | .125 | .32545 |

a. Predictors : (Constant), MTTI
b. Dependent Variable : Classroom Discussion
c. R-Squared : .137

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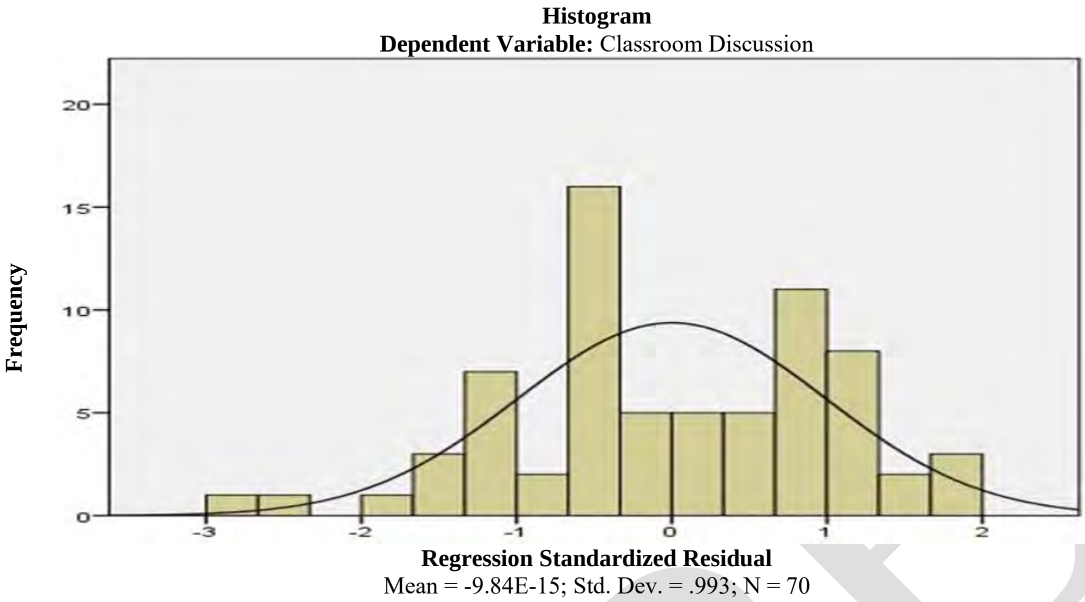


**Figure 5.** Histogram illustrating regression of teacher tech-creativity against teacher classroom discussions.

From Table 2, the results have shown that there is a positive moderate relationship (R= .370) between teacher tech-creativity and teacher classroom discussions as a classroom teaching practice. This indicates that an increase in the value of teacher tech-creativity causes a relative increase in the value of teacher class discussions in the same direction. Table 2 further shows that 13.7% of the variation in teacher class discussions is accounted for, by teacher tech-creativity. The histogram in Figure 5, further shows that the distribution is random, meaning the data patterns were not clear and distinct.

**Research Question 4**

To what extent does teacher tech-creativity foster behaviour affect teacher feedback as a teacher classroom practice?

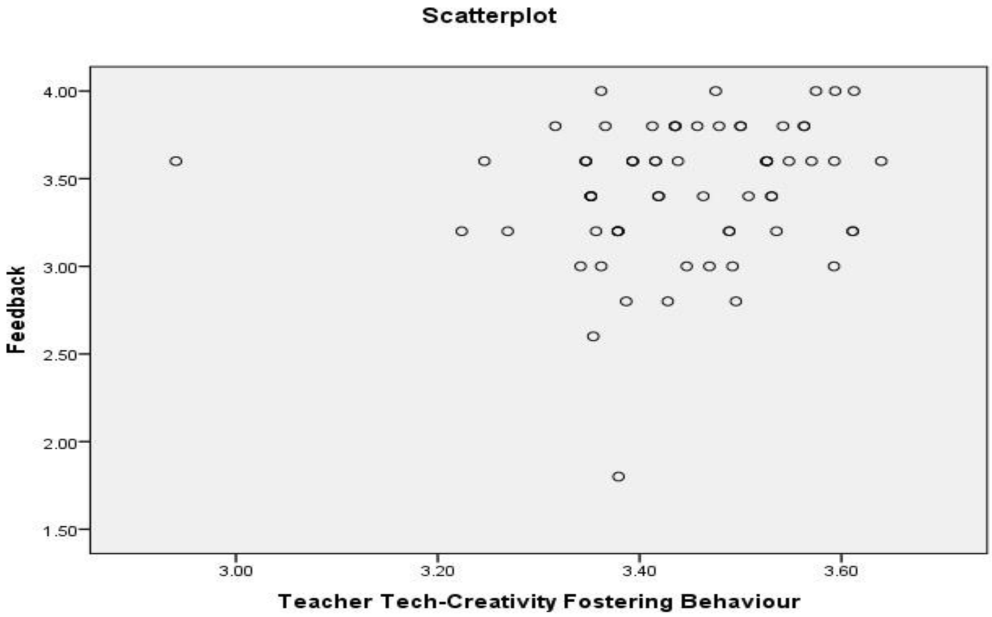


**Figure 6**. Scatterplot for teacher-tech creativity and teacher feedback.

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Results from the scatterplot in Figure 6 show a low positive correlation in the responses between teacher-tech creativity and teacher feedback as a teacher classroom practice.

**Table 3**. Correlation analysis of teacher tech-creativity and teacher feedback.

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .275[a] | .076 | .062 | .37292 |

a. Predictors : (Constant), MTTI
b. Dependent Variable : Feedback
c. R-Squared : .076

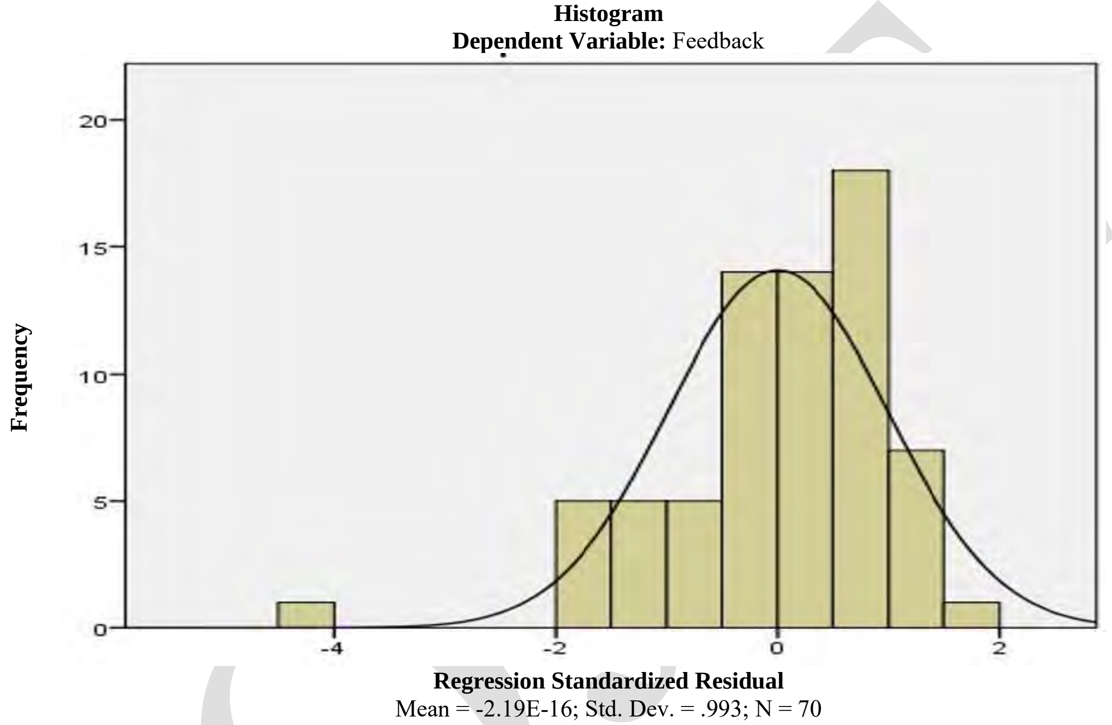


**Figure 7.** Histogram illustrating regression of teacher tech-creativity versus teacher feedback.

From Table 3, the results have shown that there is a weak positive correlation (R= .275) between teacher tech-creativity and teacher feedback as a classroom teaching practice. This indicates that although both teacher tech-creativity and teacher feedback rise in response to one another, the relationship is not very strong. Table 3 shows that 7.6% of the variation in teacher feedback is accounted for by teacher tech-creativity. The histogram in Figure 7 further shows that the distribution is negatively skewed to the left, meaning the mean value is less than the median value.

**Research Question 5**

To what extent does teacher tech-creativity foster behaviour affect teacher formative assessment as a teacher classroom practice?

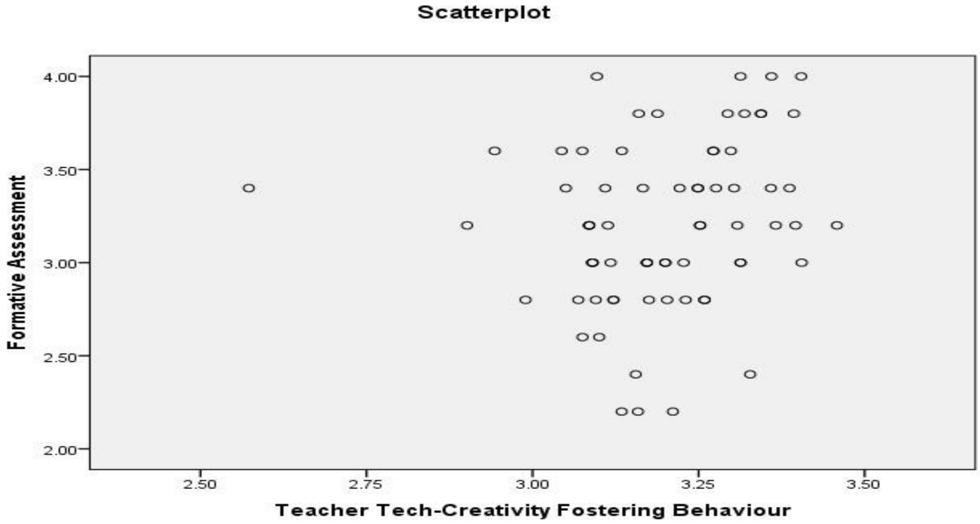


**Figure 8**. Scatterplot for teacher-tech creativity and teacher formative assessment.

Results from scatterplot in Figure 8 show a low positive relationship in the responses between teacher tech-creativity and teacher formative assessment as a teacher classroom practice.

**Table 4**. Correlation analysis of teacher tech-creativity and teacher formative assessment.

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .296[a] | .087 | .074 | .42971 |

a. Predictors : (Constant), MTTI
b. Dependent Variable : Formative Assessment
c. R-Squared : .087

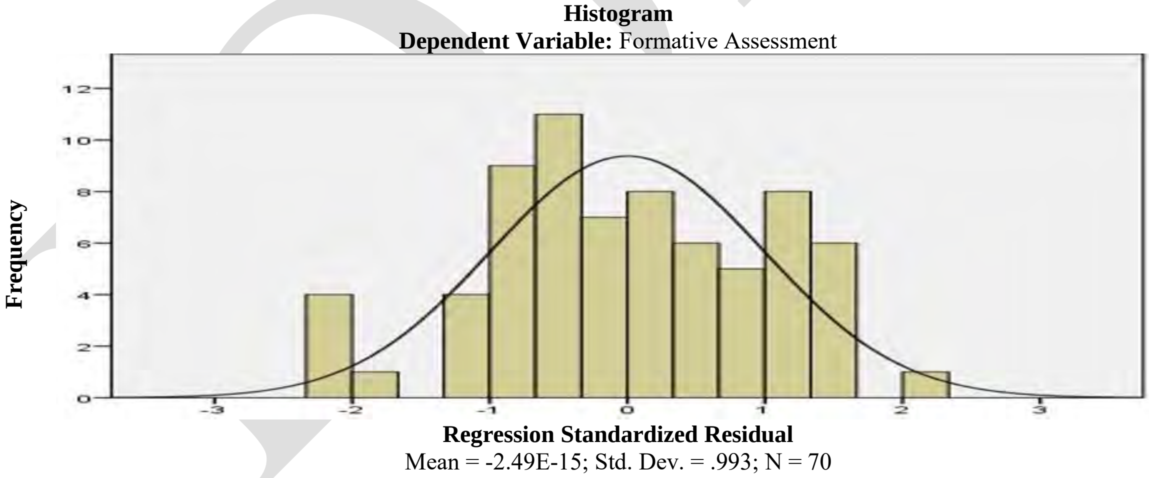


**Figure 9.** Histogram illustrating regression of teacher tech-creativity versus teacher formative assessment.

From Table 4, the results have shown that there is a moderate positive correlation (R= .296) between teacher tech-creativity and teacher formative assessment as a classroom teaching practice. This indicates that although both variables of teacher tech-creativity and teacher formative assessment go up in response to one another, the relationship is not very strong. Table 4 further depicts that an 8.7% proportion in the variation of teacher formative assessment is predicted by teacher tech-creativity. The histogram in Figure 9, shows that the distribution is right-skewed and unimodal, meaning the mean value is greater than the median value, and both the mean and the median are greater than the mode.

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**Research Question 6**

To what extent does teacher tech-creativity foster behaviour affect teacher-teacher collaboration as a teacher classroom practice?

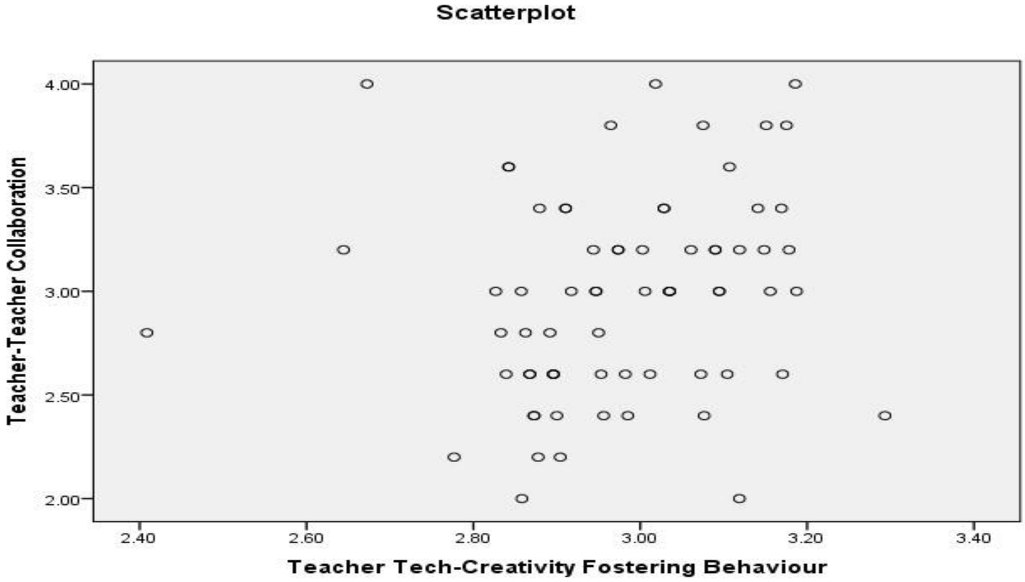



**Figure 10**. Scatterplot for teacher-tech creativity and teacher-teacher collaboration.

Results from the scatterplot in Figure 10 show a low positive relationship in the responses between teacher tech-creativity and teacher-teacher collaboration as a teacher classroom practice.

**Table 5**. Correlation analysis of teacher tech-creativity and teacher-teacher collaboration.

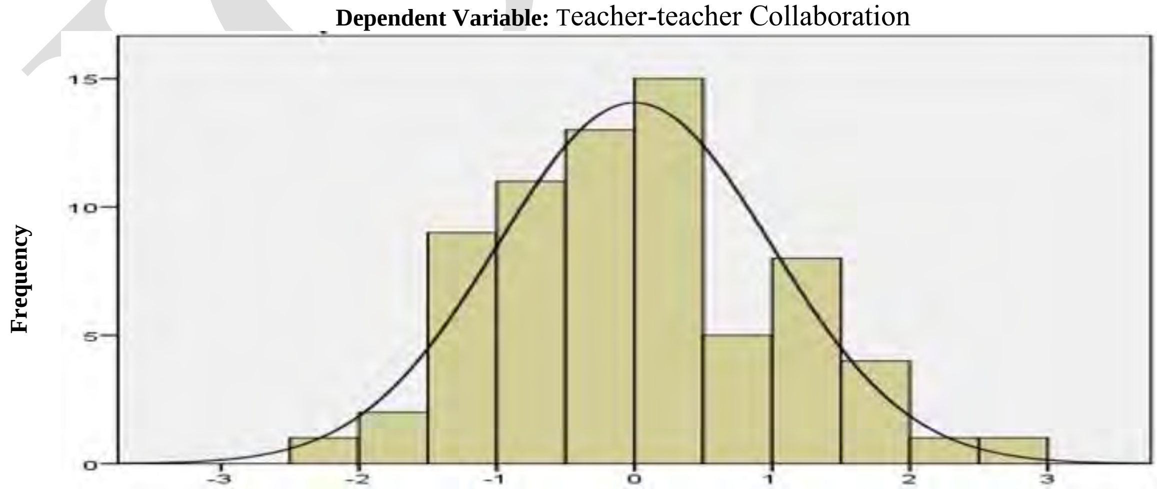
**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .285[a] | .081 | .068 | .47548 |

a. Predictors : (Constant), MTTI
b. Dependent Variable : Teacher-teacher Collaboration
c. R-Squared : .081

**Histogram**

**Dependent Variable:** Teacher-teacher Collaboration




**Regression Standardized Residual**

Mean = -7.77E-16; Std. Dev. = .993; N = 70

**Figure 11**. Histogram regression of teacher tech-creativity versus teacher-teacher collaboration.

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From Table 5, the results have shown that there is a weak positive association (R= .285) between teacher tech-creativity and teacher-teacher collaboration as a classroom teaching practice. This indicates that although both variables of teacher tech-creativity and teacher-teacher collaboration go up in response to one another, the relationship is not very strong. Table 5 further depicts that an 8.1% proportion in the variation of teacher-teacher collaboration is predicted by teacher tech-creativity. The histogram in Figure 11, shows that the distribution is symmetric, meaning the data points are clustered around the mean, with fewer values away from the mean.

**Hypotheses 1**

Teacher tech-creativity fostering behaviour has no significant impact on teacher clarity as a teacher classroom practice.

**Table 6**. ANOVA results of teacher tech-creativity on teacher clarity.

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1.069 | 1 | 1.069 | 12.527 | .001 |
| | Residual | 5.802 | 68 | .085 | | |
| | Total | 6.871 | 69 | | | |

a. Dependent Variable: Teacher Clarity
b. Predictors: (Constant), MTTI

Results from Table 6 show that, the p value (.001) is less than alpha (.05); ($F_{1, 68}$=12.53; p=.001<.05), this indicates statistical significance. Hence, we reject null hypothesis 1, then conclude that teacher tech-creativity fostering behaviour has a significant impact on teacher clarity as a teacher classroom practice.

**Hypothesis 2**

Teacher tech-creativity fostering behaviour has no significant impact on teacher classroom discussion as a teacher classroom practice.

**Table 7**. ANOVA results of teacher tech-creativity on teacher classroom discussions.

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1.146 | 1 | 1.146 | 10.815 | .002 |
| | Residual | 7.202 | 68 | .106 | | |
| | Total | 8.348 | 69 | | | |

a. Dependent Variable: Classroom Discussion
b. Predictors: (Constant), MTTI

Results from Table 7 show that, the p value (.002) is less than alpha (.05); ($F_{1, 68}$=10.82, p=.002<.05), this indicates statistical significance. Hence, we reject null hypothesis 2, and then conclude that teacher tech-creativity fostering behaviour has a significant impact on teacher classroom discussions as a teacher classroom practice.

**Hypothesis 3**

Teacher tech-creativity fostering behaviour has no significant impact on teacher feedback as a teacher classroom practice.

**Table 8**. ANOVA results of teacher tech-creativity on teacher feedback.

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | .075 | 1 | .775 | 5.570 | .021 |
| | Residual | 9.457 | 68 | .139 | | |
| | Total | 10.231 | 69 | | | |

a. Dependent Variable: Feedback
b. Predictors: (Constant), MTTI

Results from Table 8 show that, the p value (.021) is less than alpha (.05), ($F_{1, 68}$= 5.57, p=.021<.05), this indicates statistical significance. Hence, we reject null hypothesis 3, then conclude that teacher tech-creativity fostering behaviour has a significant impact on teacher feedback as a teacher classroom practice.

**Hypothesis 4**

Teacher tech-creativity fostering behaviour has no significant impact on teacher formative assessment as a teacher classroom practice.

**Table 9**. ANOVA results of teacher tech-creativity on teacher formative assessment.

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1.204 | 1 | 1.204 | 6.519 | .013 |
| | Residual | 12.556 | 68 | .185 | | |
| | Total | 13.760 | 69 | | | |

a. Dependent Variable: Formative Assessment
b. Predictors: (Constant), MTTI

Results from Table 9 indicate that, the p value (.013) is less than alpha (.05); ($F_{1, 68}$ =6.52; p= .013<.05), this shows statistical significance. Hence, we reject null hypothesis 4, then conclude that teacher tech-creativity fostering behaviour has a significant impact on teacher formative assessment as a teacher classroom practice.

**Hypothesis 5**

Teacher tech-creativity fostering behaviour has no significant impact on teacher-teacher collaboration as a teacher classroom practice.

**Table 10**. ANOVA results of teacher tech-creativity on teacher-teacher collaboration.

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 1.359 | 1 | 1.359 | 6.010 | .017 |
| | Residual | 15.373 | 68 | .226 | | |
| | Total | 16.732 | 69 | | | |

a. Dependent Variable: Teacher-teacher Collaboration
b. Predictors: (Constant), MTTI

Results from Table 10 indicate that, the p value (.017) is less than alpha (.05); ($F_{1, 68}$=6.01; p=.017<.05), this shows statistical significance. Hence, we reject null hypothesis 5, then conclude that teacher tech-creativity fostering behaviour has a significant impact on teacher-teacher collaboration as a teacher classroom practice.

## DISCUSSION, CONCLUSION, and RECOMMENDATIONS

Findings from the research show that tech-creativity fostering behaviour significantly impacts teacher clarity in class. To support this finding, Costley (2014) found that technology provides meaningful experiences for both teacher and students; by using the computer, students believed that they understood the teacher and lesson better and as well were able to recall what was taught to them previous days. The synergy of tech-creativity and teacher verbal explanations brings about clarity of lessons because mathematics teachers have to be creative when bringing about relevant instructions via technology to enhance lesson clarity.

The findings from this work show that tech-creativity fostering behaviour significantly impacts teacher classroom discussions. To support this finding, the work of Coffey (2012) found that integrating technology and peer-led discussions into teaching can produce class engagement and motivation. Herron (2012) discovered that using the internet to surf materials and get the information needed to foster learning and gainful knowledge, exposed students to mathematics activities at different levels as such students were able to engage in class and discuss their activities. When mathematics teachers find creative ways of internalizing and building technology into lesson delivery, this can foster and encourage class discussions.

Another finding from this study discovered that teacher tech-creativity fostering behaviour had a significant impact on teacher feedback as a teacher classroom practice. Male, Burden, Martin, Hopkins, and Trala (2012) found that teachers reported that iPads as digital tools enabled them to provide better feedback to learners about learning. Feedback is an essential tool teachers use to inform their instruction and assessment; it further helps the teacher to gauge students' comprehension and evaluate their teaching practices. Hence, using tech tools creatively to facilitate the process, enhances students' learning growth and helps teachers better their future instructions and assessments.

It is found in this study that teacher tech-creativity fostering behaviour has a significant impact on teacher formative assessment as a teacher classroom practice. It is along this line that Jewitt, Clark, and Hadjithoma-Garstka (2011) found that using digital learning and teaching resources provides a safer space for formative assessment and feedback. Elmahdi, Al-Hattami, and Fawzi (2018) findings also corroborate the findings of this research. It was discovered that using technology-based tools such as Plickers, enhanced formative assessment, and immediate feedback; using technology-based tools leads to creating an effective teaching and learning environment. Nicol (2008) found that technology supports assessment practices and can help teachers construct and present assessment tasks, make valid judgments of students' progress, and support the production and delivery of marks. It is worthy of note that mathematics teachers necessarily need to be creatively selective with technological tools that can enhance formative assessment of mathematics instructions.

Another finding from this research discloses that there is a significant impact of teacher-tech creativity on teacher-teacher collaboration. To buttress this finding, the work of Nwoke, Nwoga, and Emenyonu (2018) found that technology supports creativity in the classroom because it is a medium that requires interaction. Interaction comes as a result of collaboration, when people interact, they find a level ground and basis for which they can collaborate or work together to achieve meaningful results.

It can be concluded that integrating technology and creativity into lesson instructions could advertently close the gap created by conventional teaching approaches, since is it rather ideal in its sense to promote transformative classroom practices that embrace creativity, technology, and education to help empower teachers to successfully implement instructions and educational goals. Technology alone will not enhance teaching and learning, but using it creatively has enhanced teacher clarity, teacher classroom discussion, teacher feedback, teacher formative assessment, and teacher-teacher collaboration as part of good teaching practice that can open new doors for learners and teachers.

**Recommendations**

Teachers of mathematics should consider utilizing technological tools blended with a creative mindset to help foster innovative approaches to instructions during lessons since this can advance classroom teaching practices. Promoting this practice can further impact teachers' skills and professional development creatively to enhance teacher clarity, teacher classroom discussion, teacher feedback, teacher formative assessment, and teacher-teacher collaboration.

**Limitations**

This work is limited to only private schools in Makurdi Local Government Area of Benue State, since they mandatorily make provision for necessary infrastructures and resources to handle technological tools; hence generalizations cannot be inferred on the entire Benue State. In Benue State, there are urban and rural districts where schools are located, rural schools will not have enough facilities and mechanisms to effectively man technological tools due to environmental conditions. Additionally, tech-creativity and teaching practices have not been observed but have been conducted by self-report data, which can be distorted because of different understandings of the items or biased due to social desirability (Safrudiannur, 2020).

**Ethics and Conflict of Interest**

All ethical rules were observed at all stages of the research. Authors declare that they acted in accordance with ethical rules in all processes of the research. Authors declare that there is no conflict of interest between the authors of this work.

**Author Contributions**

All authors' contributions to the article are equal in every aspect. All authors have read and agreed to the published version of this work.

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