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USING PYTHON-BASED ASSISTIVE TECHNOLOGY IN TEACHING GEOMETRY AT BASIC EDUCATION LEVEL

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ABSTRACT

This study examined how to fill the gaps in the creation, curation, and provision of reasonably priced and instructor-friendly educational tools by developing and putting into practice an interactive Python-based application which is specially made to teach the concepts of angles and triangles to pupils with learning difficulties in the low income primary schools in Nigeria. The tool is structured with a layered architecture comprising presentation, logic, data management, and external dependency layers while applying based on the available evidence, the instructional principles such as cognitive load management via the single-concept presentation, learning through sight and touch all combined in the same context, difficulty ramping up gradually over three levels, immediate correction feedback loops, and the always being able to try again, where the environment is set to be helpful. The tool, hosted on Google Colaboratory which is a cloud platform requiring no installation, is developed using free, open-source technologies like Python, Matplotlib for graphics, NumPy for mathematical computation processes, and IPyWidgets for the development of interactive interfaces, hence the system is able to overcome the usual hindrances of software cost, installation requirement, and the need for a high level of technological proficiency. The product thus managed to single out the specific cognitive issues of children with dyscalculia and those with geometry learning problems - among these are found impairments of visualization, deficits in memory and slow information processing. The use of the tool requires no understanding of the programming language and teachers will get a clear visual display that will not only help them in assessing but also in making a decision on the instructional steps to be taken. The study is an indication of how thinking out the Ed-Tech thing by adjusting it according to the constraints on local infrastructure and educational needs can give birth to the most effective and lasting innovation that will enable access to geometry education by all, therefore, also having the ability of wider application all over sub-Saharan Africa and other developing regions as well, depending on the presence of educational policies promoting inclusive education.

KEY WORDS—*Learning Disabilities, Geometry Education, Python Programming, Assistive Technology, Inclusive Education, Educational Technology, Primary Education.*

INTRODUCTION

The core of the early phase curriculum for the pupils, is the ability to have a good reasoning and problem-solving skill. Mathematics is one of the subjects that can easily influence every field of learning. Part of Geometry curriculum is designed to develop spatial reasoning and problem-solving skills in young learners that is essential to science, technology, engineering, and mathematics (STEM) learning. Some pupils are challenged in their daily life with the disability of problem-solving and reasoning skills. This means playing in the field with their friend, gaming and discussion are relatively difficult. However, students with learning disabilities have serious problems of visualization, abstract concept comprehension and retention of spatial relations (Al Hadi and Zhang, 2025; Chen et al., 2021). Nigeria is not exempt from these challenges that are further complicated by structural barriers like poor infrastructure, an insufficient number of qualified special education teachers, and inadequate funds for inclusive programs, among others (Agbon et al., 2025). A recent report indicates that infrastructures that would enable pupils in low income schools with learning disability are not available in a lot of sub-urban and rural schools hence making teaching and learning very difficult. There are still many disabled children who are out of school (TheCable, 2024). The Discrimination Against Persons with Disabilities Act (2019) and the National Policy on Inclusive Education (2023) are examples of initiatives that have been implemented, but they are still limited by insufficient resources. The traditional teaching methods represented in a static way have not supported at all the students with learning difficulties (Federal Ministry of Education, 2024; Garuba, 2020).

Educational technology (Edu. Tech.) has been identified as a promising approach for learners in underdeveloped countries. Many researches indicates that mathematics achievement increases dramatically in the technology-enhanced learning environment while remaining cost-effective (Rodriguez-Segura, 2022). Research from these countries shows that conventional strategies has led to significant improvements in learning according to Angrist et al. (2022). Angrist et al. (2022) states that many schools have improved by 0.89 standard deviations for every $100 spent in training teachers and providing infrastructure. Python's extensive collection of libraries, like matplotlib for graphics, numpy for calculating, and ipyWidgets for interfaces, allows educators to develop complex learning tools without a full understanding of programming concepts (Samra 2025). The most useful tool is Google Colaboratory, which is available

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for free, works on the computer with a poor central processing unit (ÇPU) or graphic processing unit (GPU), doesn't require software installation, and can be used on any of the internet devices, even the mobile phones (Amiri & Islam, 2025; Zabala et al., 2024). Providing learning support to elementary school students with learning disabilities is one of the major activities that educational institutions have to deal with in terms of the country's educational policy. Liu et al. (2021) and Rodriguez-Segura (2022) have pointed out that the tool that is being used by teachers at present is prohibitively expensive, complex to use, tiring for the Nigerian students, and hence it requires ele else's instruction.

This study intends to fill the gap that exists in teaching angles and triangles by designing and implementing an interactive leaner-friendly Python-based tool for primary school pupils with learning disabilities in a low income cities and rural area. The tool reflects key design principles for both pedagogical and practical considerations: single concept representation to reduce cognitive load, multisensory learning, visual and interactive, scaffolding of progressive levels of difficulty, immediate corrective feedback, and unlimited practice in a supportive environment. Recognizing that the teacher is the key to educational technology success, the tool does not require programming knowledge to operate, has clear visual feedback in support of instructional decisions, allows flexible pacing based on students' individual needs and allows for classroom demonstrations. By taking advantage of the zero-installation platform of Google Colaboratory and using completely free open-source technologies, this research presents a replicable model that can be adopted by schools without financial challenges. This method will directly solve financial challenges that have always restricted technology integration in Nigerian schools.

This work is significant in a number of ways: it demonstrates how evidence-based special education guidelines can be translated into reasonably priced forms of Technological Enhanced Learning Tools. This tool can address specific cognitive challenges in low resource settings; it provides Nigerian teachers with a useful model of application that can demonstrate how freely readily available tools create inclusive, exceptional educational opportunities without the need for expensive equipment or specialised training; and it addresses a critical intervention point where assistance can prevent cascading challenges with learning which have negative impacts on students with disabilities. The design of the tool is specifically based on the Nigerian educational context, which has large class numbers, little one-on-one time, and diverse backgrounds of teacher training. This is part of the bigger debate on which technology is acceptable for developing nations. The remainder of this paper reviews related literature (Section II), describes the research methodology (Section III), presents detailed system design (Section IV), discusses implementation and deployment (Section V), analyzes evaluation findings (Section VI), and concludes with contributions and recommendations (Section VII).

LITERATURE REVIEW

Types of Learning Disabilities Affecting Mathematics Education

Learning disabilities represent neurodevelopmental disorders affecting reading, written expression, and mathematics, with approximately 6% experiencing mathematics-related difficulties (Chen et al., 2021; Soares et al., 2018). Dyscalculia, marked by the chief disability in mathematics learning, has three specific branches: procedural (in which the person has a hard time performing mathematical procedures), semantic memory (in which it is hard to memorize arithmetic facts), and visuospatial (in which the person has a hard time recognizing spatial relations) (Karagiannakis et al., 2014). Dyscalculia, marked by the chief disability in mathematics learning, has three specific branches: procedural (in which the person has a hard time performing mathematical procedures), semantic memory (in which it is hard to memorize arithmetic facts), and visuospatial (in which the person has a hard time recognizing spatial relations) (Karagiannakis et al., 2014). Students experience cognitive deficits including working memory impairments, number sense deficits, and processing speed limitations (Butterworth, 2010; Soares et al., 2018). In the field of geometry, students may have challenges including difficulties in mere visualization, memory deficits impairing the retention of formula, and limited processing speed, with the performance getting worse as the complexity increases. (Chen et al., 2021; Choo et al., 2021).

Geometry education interventions for students with learning disabilities

Interventions in geometry, which are effective, combine systematic explicit instruction with various representations and interactive technology (Liu et al., 2021). In a recent study, Al Hadi and Zhang (2025) revealed that the use of schematic chunking interventions to organize the learning process is an effective method and that memory load is reduced as a result of the short problem segments which are shifted to form the visual motifs. The process of scaffolding is a continual provision of aids that are slowly taken away once the student shows more and more competence. This way the student's confidence grows and at the same time, they are spared failing in the learning process (Liu et al., 2021). Feedback that is immediately given enables students to see where they are wrong, and thus correct their errors even before they deeply misunderstand, thus supporting the easy formation of the concept and fluency in the procedure (Al Hadi & Zhang, 2025). These practices, which are massively supported by evidence, come to the aid of load management in cognition, which is a fundamental issue for those with learning disabilities that are exposed to feelings of frustration as well as mathematical anxiety.

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Technology Integration in Mathematics Education for Different Learners

According to Rodriguez-Segura's (2022) study, the use of technology in teaching is one of the most powerful methods to boost students' math learning aptitude. Additionally, it doesn't cost a lot of money to implement in underfunded schools. A research has been conducted by Angrist and his colleagues in 2022 and they have revealed the finding that minimal spending on IT leads to the same outcomes, the reason being the "effect size," for instance, the improvement in standard deviation units for every US$100 spent, was found to be 0.89. As far as the geometry instruction is concerned, the use of ICT during the classes can provide many interactive visualization tools that convert the abstract concepts into something that can be manipulated and that are easier to understand (Arvanitaki & Zaranis, 2020). One of the virtual tools that are usually employed in maths teaching to the benefit of the children is the computer software GeoGebra, as it is good for learning by doing through the students' own exploration of the subjects and at the same time to receive instant visual feedback (Mutambara & Bansilal, 2022; Njageh et al., 2024). To give an example, the interpretation of augmented reality in the context of the learning of three-dimensional geometric shapes is at once one of the areas of interaction and one of the main sources of the development of spatial reasoning in children (Volioti et al., 2023). It was also on account of the practice of multiple cases, on-the-spot feedback, and the adjustment of the difficulty levels automatically that technology-assisted learning was proven to be so effective.

Artificial Intelligence (AI) and Assistive Technologies for students with disabilities

The collaboration between AI and assistive technologies can be considered as a means of making the whole process more efficient and effective for both teachers and students and may even enhance learnability and the learning outcomes themselves in some cases. By working together, AI and assistive technologies come up with a sort of an integrated system which can be characterized as adaptive, intelligent (Dumitru et al., 2025). AI-driven technologies are likely to feature direct, immediate, and integration access to current and more structured and organized information in a cheaper and faster way than before. It is not only a matter of providing the students with the necessary tools for overcoming their difficulties, but also of making the learning process more interesting. It is also a great step towards making the schools everywhere inclusive and to reducing learning disparities among students, (Brewer et al., 2022; Every Learner Everywhere, 2025). For cognitive disability arising from brain injury, the AI revolution is offering hope both through its holistic solutions and through more specific solutions which can be seamlessly provided (Every Learner Everywhere, 2025). L., Study Says So Far., L. Soon., and Co., and/or, Other People Say that., etc., than the traditional teaching would be., the consumption of time for covering the curriculum lessons and materials being decreased, so on., (Singh et al., 2025). ; Learn., Choose., Make., Gain., Enjoy; Read., Calculate, etc.; Similar, But Not the Same., Create., Don't: You Are Just., Do.,, (Singh et al., 2025). IsNot: If It., Won't Just Get The. It's A Do., And Context., (Singh et al., 2025).

Python programming in educational technology development

The clearness of Python's syntax, the wide range of libraries, and the ease of use of the language is what makes it very suitable for educational technology applications (Amiri & Islam, 2025). The educationally qualified language users can, through its readability, sustain and make changes to learning tools in the absence of strong programming skills the very critical thing in any time resource-strained areas' deployment of educational tools (Samra, 2025). The libraries are very powerful, among them being the well-known Matplotlib for graphics, NumPy, and IPyWidgets for computation and interactive interface components respectively (Samra, 2025). Google Colaboratory deployment gives the following benefits: it removes the difficulty of installing software, it can be used on any internet-connected device, even on less powerful computers, it saves automatically to avoid data loss, and it provides free computational resources (Zabala et al., 2024). All this makes Python with Colaboratory the best choice for Nigerian environments that have limited resources and face financial challenges (Rodriguez-Segura, 2022).

Inclusive education in Nigerian context

Even though there is a law now in place that covers Discrimination Against People with Disabilities (2019) and the National Policy on Inclusive Education (2023) has already been implemented, the application of these rules remains to be a major problem (Federal Ministry of Education, 2024). One of the main obstacles in the road of access to education for disabled children in Nigeria is the fact that education in more than 85% of schools is not equipped with special features for disabled people, and distinctively, only a little less than two-thirds of disabled children are able to access, let alone complete, education (TheCable, 2024). The main challenges the educational sector in the country is encountering with respect to disabilities and accessibility are: lack of appropriate facilities, lack of training of teachers especially in the area of special education, very large class sizes, cultural rejection, and mone-restricted (Garuba, 2020). Teachers are not praised, for their ability to successfully instruct a range of students with diverse needs, that allows for change to involve the adaptation of the school environment rather than the subject to qualification changes or any other school policies; people who are part of the school but not directly involved in the teaching-learning process are still concerned about the quality and quantity of educational services offered to students with disabilities. Teachers will play a most important role in the successful implementation of any educational technology intervention, provided that the tools and methods that they use are well integrated into the teaching-learning process and that they are fully aware of the potential problems and the best ways of dealing with them (Rodriguez-Segura, 2022).

Research gap and contribution

Basic geometrical concepts teaching to children with learning disabilities in low-income areas is not properly backed up with the necessary tools and devices because the resources are not only hard to find but they are expensive too. This was the result of a study mentioned in two papers that came out recently (Liu et al., 2021; Rodriguez-Segura, 2022). The current software does not seem to have the necessary ability in terms of meeting diverse constraints at once: availability of resources, financial support, technology, and even cultural appropriateness in a Nigerian context. However, scarce are the resources available to implement such tools and make them accessible for all practitioners, particularly in the case where intervention components have already been established as effective according to the meta-analyses conducted. This research addresses these gaps through a teacher-friendly, interactive Python-based tool leveraging free, open-source technologies deployable through zero-installation cloud platforms, incorporating evidence-based instructional principles proven effective for students with mathematics learning disabilities.

METHODOLOGY

The analysis of the study was based on the principle of the SDLC model, with the main focus on the learner and both the design and implementation processes being made through that prism and the result is a user-friendly geometry tool that runs on Python and meets the needs of the 9-12 year old pupils with learning issues. Also, it was constructed following an SDLC four-stage framework: system investigation, system design, implementation and monitoring. This methodology was deliberately chosen because its systematic approach ensures that every development stage explicitly addresses the unique cognitive, emotional, and educational needs of pupils with dyscalculia, dyslexia, ADHD, and other learning disabilities. By centering pupils' needs throughout the SDLC process, the development approach prioritized accessibility, engagement, and learning effectiveness over technical sophistication, ensuring the final tool would be genuinely beneficial for this vulnerable population.

Before the System Analysis Phase started, a comprehensive needs assessment was carried out to determine the particular learning challenges that students with learning disabilities face when learning geometric ideas. The study identified significant obstacles such as short attention spans, working memory limitations, difficulty with abstract concepts, visual-spatial processing difficulties, and mathematics anxiety resulting from repeated failures. The needs of the pupils were used to gather explicit functional requirements: multifunctional learning opportunities that combine visual, sensory, and textual modes; simplified interfaces minimizing cognitive overload; progressive difficulty levels (Level 1: standard angles 30°-90°, Level 2: multiples of 15°, Level 3: random angles) matching individual learning pace; error-tolerant validation systems accepting approximate answers within tolerance ranges (±5° to ±15°); examples of these approach include: quick, positive feedback that removes the fear of failure; cognitive scaffolding in the form of hints which do not give away all the answers; and gamification elements (such as levels and score) which help to stimulate intrinsic motivation. Non-functional criteria were: cross device usability using a browser interface, a private learning environment to reduce anxiety from comparing the achievement of peers, and zero install distribution using Google Colaboratory to ensure equal access. The technical specifications were identified through a comprehensive study based on the challenges identified by the students with learning difficulties. The System Design and Implementation Phases used object-oriented programming concepts in Python 3.x. to transform student-centered requirements into a useful learning aid. The system architecture has four layers which were especially made for accessibility and adhered to the Model-View-Controller (MVC) pattern: The Presentation Layer includes emoji-enhanced feedback (🎉, 💡), high contrast colour schemes (blue for learning, green for success, yellow for hints, and orange for retry) to support visual processing impairments, and large clickable buttons (200px * 50px) for fine motor difficulties Establishing amiable, non-threatening interactions and enduring reference guides to help with memory issues The Logic Layer putting in place intelligent question generation with content appropriate for the level of difficulty; the Data Management Layer keeps track of temporary session progress without storing it permanently, which protects privacy. The Rendering Engine uses Matplotlib to create clear, simple geometric visualisations with bold lines (linewidth: 4), colour coding that makes sense, big vertex markers (markersize: 12), and numeric labels for students who are better at processing numbers than spatial information. The two learning modes—angles and triangles—were changed in specific ways. For example, triangle mode shows side length measurements to help students who have trouble with spatial reasoning with visual discrimination. Angle mode, on the other hand, uses visual arc representations with question marks to create a puzzle-solving rather than testing atmosphere. The implementation put Universal Design for Learning (UDL) principles first, giving users many ways to represent, interact with, and express themselves through the interface.

The Evaluation Phase evaluated the effectiveness of the tool in the case of pupils with learning disability directly through extensive usability testing on the basis of the pupil-oriented criteria. Cognitive accessibility measures assessed the simplicity of the interface (Can pupils use independently?), geometric representations understandability (Are geometric representations unambiguous?), feedback comprehension (Do pupils understand messages?), and appropriateness of difficulty progression. The measures of engagement evaluated the ability to sustain attention, readiness to persistently make mistakes, self-directed learning behaviour, and mathematics anxiety reduction. The validation of accessibility indicated high contrast ratios of visual processing difficulties, as well as correctly sized interactive elements of motor coordination difficulties, single concept presentation of cognitive overloading, and motivating language

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throughout promotion of positive self-concept. These assessments were refined in iterations, which included a bigger size of buttons, better colour contrast, simplified feedback language, and emojis ensure it is friendly. In the deployment plan, maxims were used to ensure the widest access of pupils by the free, zero-installation, browser-based platform of Google Colaboratory, with visual user instructions to the pupils and teacher implementation manuals. The privacy protection was provided by avoiding the collection of personal data, psychological safety by lack of judgmental feedback and lack of failure states, and educational equity with the free accessible design. This holistic SDLC strategy led to a tool in which all the design choices such as the tolerance ranges or even color choice directly relate to the experience and interaction of the learner with learning disabilities with the educational content making it not just a teaching tool but a helpful learning environment in which pupils can gain mathematical confidence and experience success in geometry.

System Design

The Geometry Learning Tool is built with a layered architecture that facilitates the usage, administration, and comprehension of it by students with learning difficulties. There are four main layers in the system, working together to provide an enriched learning experience. The Presentation Layer takes care of all user interactions and the display of visual content. The primary learning activities are the responsibility of the Business Logic Layer together with the reception of user input. The creation and monitoring of questions, answers, and user progress happens in the Data Layer. The tools for arithmetic, graphics, and user interface components that you need are all provided by the External Libraries Layer. Each component has a special function due to the layered design making the system reliable and easy to modify.

Presentation Layer Architecture

The Presentation Layer is the primary component of the system that students directly interact with. It has very colourful buttons and easy to read to help with learning challenges. In addition, the layer includes six main parts: Mode Selector buttons allow students to choose between angles or triangles, Level Selector buttons have the three difficulty levels (Easy, Medium, Hard), a Canvas Display area shows geometric shapes with clear and bright colours, Input Fields for students to input answers or choose triangle categories, a Feedback Display to give motivating messages based on the accuracy of answers, and a Score Tracker to keep track of the continuously increasing points and motivate the students with cumulative points. Throughout the whole interface, high contrast colours and explicit labels of the elements were the two strategies used for enhancing the interface design and making it easy for users to go through the navigation of the app.

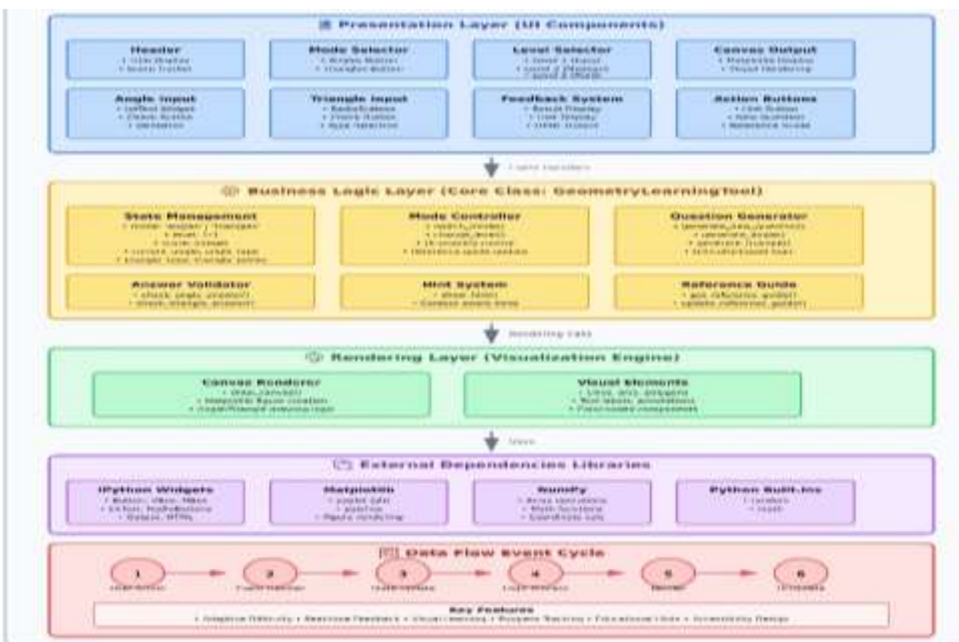

Figure 1 Interactive Geometry Learning Tool design

The Interactive Geometry Learning Tool as an application followed the systematic design of a three-level framework with the prime objective of enhancing the user interaction by means of pedagogical functions. The first of the layers, The Presentation Layer has a user-friendly interface that consists of the use of mode/level selectors and an interactive canvas along with it, The Business Logic Layer is responsible for the basic functionalities of the application such as state management, checking answers, and generation of help questions on the basis of the user's performance level. The rendering layer employs the matplotlib library to provide the user with precise and reallife geometric figures. If this architecture is to be upgraded, a good idea would be to switch to web-based paradigm with React.js implemented for the front end, since that would bring in more responsive UI components and enhanced cross-platform compatibility. The backend part should be moved to a Node.js backend with a dedicated REST API, which will give more space for scaling and keeping the concerns apart at the same time. Also, the visualization should be taken care of by introducing D3.js so that more dynamic and interactive geometric renderings are made possible as compared to static Matplotlib outputs.

Moreover, the usage of a cloud-hosted user profiling system is going to open up tracking across sessions and the interactive features in real-time would make it easier for the learners as a group. The system of hints could be improved by means of the AI-guided personalized hints based on machine learning that would contribute to students receiving personalized learning paths. The revamped system would keep the educational base of the tool intact but at the same time, it would significantly increase accessibility, interactivity, and analytical capabilities of the tool.

Logic Layer Design.

The Logic Layer's design is the most extended part of the system and it is responsible for controlling all learning activities. The Main Controller (GeometryLearningTool class) is at the centre of this layer and it is the one who runs all the processes. There are six functional modules in this layer: the Mode Manager helps to change between angles and triangles modes, and also it updates the interface as needed, the Question Generator makes random questions depending on the selected mode and difficulty level, the Answer Validator checks the user answers with a tolerating range dependent on difficulty level, the Score Manager looks at and updates the student's points earned, the Hint Provider comes in with the hint's which will help the student figures but without disclosing the answer, and the Drawing Engine is in place to carry on the rendering of geometric shapes on the canvas through mathematical computations. These modules act uniformly to provide a pleasant learning environment wherein students have immediate feedback and are presented with customized challenges based on their level of skills.

Data Layer Design

The Data Layer is responsible for the job of questioning using data in the entire system. In the case of angle learning, the Angle Data Generator is responsible for framing the questions based on the difficulty: Level 1 makes simple angle questions (like 30°, 45°, 60°, 90°) which are usually found in the textbooks, Level 2 makes angles in multiples of 15° (15°, 30°, 45°, all the way up to 165°) for a better challenge, and Level 3 generates a random angle between 10° and 170°. In the part of the triangle learning, the Triangle Data Generator presents the three main types being: Equilateral triangles which means that all sides are equal length, Isosceles triangles with two sides equal and Scalene triangles which are having sides of different lengths. The Validation Rules component and the control mechanisms of the correct answers and tolerance ranges: ±5° tolerance for Level 1, ±10° for Level 2, and ±15° for Level 3 angles. The Score Storage keeps the total number of points earned, while the User State keeps track of the current system operation mode, the difficulty level, and the number of the question active. The form of the User State ensures the uniformity of the questions' level of difficulty and the impartial grading of students.

Drawing Engine Design

The Drawing Engine is a special module that aims at marking technical depictions of geometrical phenomena. To show clearly the angle illustration, the engine makes the following: a main horizontal line that is always a reference, a slanting line showing the angle that needs to be measured, a curvilinear arc that connects the two lines and highlights the angle, a question mark that stands for the unknown angular value, and, finally, a point (the vertex) created where the two lines cross. In the case of the triangle, the engine uses lines that are clearly joined to form a closed polygon in the triangle shape, has three distinctly colored vertex points with the labels "A", "B", and "C" at the vertices, places the lengths of the sides of the triangle as computed on each side, and finally, the subtle shade in the triangle so as to make it more visible. The mathematical models are strictly followed in the drawing processes for precision: angles are first converted from degrees to radians to get the exact graphical representation, the coordinates of the triangle are calculated based on the type of the triangle (equilateral, isosceles, or scalene), and the lengths of the sides are calculated by using distance formulas between the coordinate points. This method of using the visual aids is not only good at the abstract geometric concepts but also very helpful in developing the students' skills who are learning geometric concepts.

Architectural design of the Feedback and Hint System

The provision of multiple opportunities is so diligently built into the feedback mechanism that it is there to be heard or seen even by the most disabled learners by throwing optimistic jerks and bits of advice. In the case of a student giving in an answer that is correct, the system will not only display a flashing success message with the celebration emoji ("🎉 Correct! Great job!"), but also give points as a reward (10 for angles, 15 for triangles), and furthermore, will move on to the next question automatically as soon as a little break has been put in place in order to keep learners engaged. On the contrary, in case incorrect answers are submitted, the system acknowledges the learners with an empowering message ("Not quite. Try again!") which also points the way, that is, the same context which the

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negative phrasing avoided. It also gives certain hints based on the context of the challenge the student is facing with the angle or triangle making and learning, like the various qualities of the triangle. Lastly, the user is welcomed and encouraged to try as many times as needed to feel confident enough about the subject, a penalty-free unlimited. The Hint System provides tiered assistance: for angles, it categorizes whether the angle is acute.

Design considerations for Accessibility

The tool's ease of use and effectiveness for students with learning disabilities are ensured by specific design principles. The tool's interface uses a simple layout with only one main task being displayed at a time to prevent the students from getting too much information all at once. The coding is done in the same colors: blue for angles mode, purple for triangles mode, green for the right feedback, yellow for hints, and orange for decisions. The text is clear, bold, and large (at least 12pt) with straightforward and age-appropriate vocabulary in the labels. The interactive elements like buttons are made bigger (at least a 40px height) and are not crowded to cater to the students' motor abilities. The system gives feedback right away within milliseconds of getting the answer, which helps the students to see what their actions caused. Scores are posted for students to monitor their progress and the system to reward them, as a form of motivation and sense of achievement. Time is not a factor of the process–each child "sets up their own learning pace" and thus there is no pressure. All of these elements culminate into a learning environment that is inclusive and addresses the needs of different learners.

Justification for Technology Choices

The choice of technologies was influenced by characteristics like availability, ease of use, and the effectiveness as an instructional tool. One of the biggest reasons why Python was used as the programming language is the fact that it has a very simple and legible coding structure. Besides, it makes it easy to work on the code and change it as per the need. This language also has broad library support to do graphical and mathematically-based operations. Moreover, it has quite a large community providing multiple resources and tools for the users in the academic sector. For the purpose of providing a running environment, Google CoLab was one of the best choices as it does not require any software to be installed on the students' devices and it is a complete running environment within the browser making it platform-independent. In addition, it is a free to use platform thus no monetary costs are involved, and it takes care of certain safety issues like the à la automatic saving of the activities by which users are protected from a loss of work. The other frameworks and libraries which serve the same motive are Jupyter notebooks, which give an in-browser interface for code execution, and some ready-to-use plugins and Kernel support for the most commonly used languages like C#, Java, SQL, R, Python, etc. It was quite a difficult choice to make and following a thorough research we decided not to use the afore-mentioned framework. Each one of these three undoubtedly proved to be the best choice according to their respective characteristics. On top of the other benefits, the platform survives the catastrophic failure of data servers and provides the facility to the user to save all their work locally or on a virtual drive. In addition, the user.

Flowchart

The Mode Switching Flow depicted in Figure 1 illustrates the system's intelligent response when a pupil with learning disabilities selects between the two primary learning modes: Angles or Triangles. When the pupil clicks either the "Learn Angles" or "Learn Triangles" button, the system processes this input through a decision node that identifies the chosen mode and performs mode-specific procedures. For Angles mode, the system assigns the internal variable to 'angles', presents the numeric input field for degree specification, and conceals triangle-related interface elements; in contrast, Triangles mode activates radio buttons for classification (Equilateral, Isosceles, Scalene) while suppressing angle-related components. This mutually exclusive interface design serves to significantly reduce cognitive load by displaying only one geometric concept at a time, thereby avoiding excessive visual stimuli that could impair pupils with working memory constraints, dyscalculia, or ADHD. Following mode selection, the system performs three essential functions: updating button styles to emphasize the active mode with primary blue coloration, delivering clear visual feedback for pupils with processing challenges; automatically generating a new question calibrated to the appropriate difficulty level, ensuring immediate cognitive engagement; and toggling the reference guide between Angle Reference (definitions of acute, right, obtuse angles) and Triangle Reference (characteristics of equilateral, isosceles, scalene triangles), thereby providing contextually relevant mnemonic support. This rapid, single-click mode transition requires no additional confirmation steps, accommodating limited attention spans while promoting learner autonomy—allowing pupils to freely navigate among geometric concepts without penalty and fostering confident exploration for those experiencing mathematics anxiety.

Discussion

This study is a very good example that low-cost and user-friendly technology for educators can greatly help to overcome and/or even remove the problems that students with difficulties in geometry learning do experience, especially in Nigeria, where resources are very limited. The installation-free deployment of the Python-based application through Google Colaboratory is a strong measure that no longer letting the constraints of costs, infrastructural demands, and technical skills be the main objects of the way. By closely integrating practices endorsed by experimental research such as cognitive load optimization, multisensory engagement, incremental scaffolding,

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and immediate feedback, the tool greatly supports the learning process by being easy to use even for teachers who are not very technically savvy. The results of this study verify that purposely adapting the contexts to limitations technological educational solutions lead to the creation of long-term and inclusive innovations that empower and equalize the social status of the marginalized groups.

Summary

This study set out to make a tool for Nigerian special needs primary school children, which was Python-based, interactive, and engaging, to help them learn the concepts of angles and triangles. The tool is a combination of readily available technologies and Colab's cloud platform, which makes the user able to directly access the system from a web browser, and provides him/her with the services of a cloud-based virtual machine (VM) running the software. The students get the help of dual pedagogical paths, different levels of difficulty, instant feedback, and the provision of hints related to a specific task for context. At the same time, the tool answers the need for rather complicated and costly technologies in an under-resourced environment while, at the same time, reflecting the principles of scientific education. The tool's design integrates successfully the requirements of the cognitive accessibility norms, the expectations of the teachers' practicability, the economic sustainability of the project, and the architecture's characteristics, thus creating a model that can be copied for making the mathematics education be accessible to all students.

Recommendations.

Based on the evidence,

1. A professional orientation is a necessity, advancement in the educational system toward more effective teaching of the sciences, a result of the forthcoming significant changes in science curricula.
2. Teachers need to be provided with all the technological tools that would not just assist them in their teaching but make the learning process more engaging as well. All of these things gave life to the idea that the teacher did not have to be confined within his/her school nor did he/she have to deal with the same burdens that teachers had been bearing for years.
3. The time is now where technology has revolutionized teaching, bringing in the computer as the new teacher at school.

Conclusion

By solving the most critical problems, this study attempts to introduce accessible geometry learning to students with learning disabilities in Nigerian primary schools by giving a teacher-friendly, Python-based interactive tool that can be put to use through Google Colaboratory. It demonstrates and considers several educational issues of Nigeria and addresses the same through a very practical model that school that have the least resources can adopt. The final solution makes the students feel at home with the lesson especially those with various challenges relating to processing information, memory, and speed in Mathematics. Further analysis from the study suggested that the tool was indeed effective in creating a suitable learning environment for students with disabilities caused by factors such as the above. Examples of this approach are also bringing benefits to other regions beyond Nigeria if the bring about issues of appropriate technology for the context of developing countries and Norway.

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