An International Multidisciplinary Journal
अनन्यशास्त्रम्™
(A Unique Treatise of Knowledge)
ISSN:3049-3927 (Online)
Volume: 01 | Issue: 02 | August: 2025
Review Article

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
Peer-Reviewed | Refereed | Open Access Journal
DOI: https://doi.org/10.64328/aimjv01i02072

Reimagining Applied Trigonometry: Moving from Classical Ideas to Modern Tools

Vinit Sachania*

Abstract

This study introduces an innovative method of practical trigonometry by associating the theoretical ideas with the real-world measurement techniques and contemporary instruments. It challenges the traditional compartmentalization of trigonometry as an abstract field, arguing that such isolation limits its effective potential in branches such as civil engineering, architecture, geology, astronomy, and navigation. The research critically evaluates the use of modern equipment such as digital theodolite, Arduino-based sensor, and mobile measure applications in solving trigonometric problems associated with height, distance, and spatial analysis. In addition, it revisits the historical measurement system to propose an integrated educational structure that combines conventional methods with modern technology. This hybrid model promotes experimental education, inter-subject connection, and technical literacy. Emphasizing hand-pen experimentation and inter-subject cooperation, the research wants to revive trigonometry education, which makes it more attractive, applicable and prepare for the future for students and professionals.

Keywords: Practical Trigonometry, Measurement and Instrumentation, STEM Education, Experiential Learning, Interdisciplinary Integration.

Introduction

The Greek word trigon (triangle) and the triangle (measured) trigonometry have long become a basis of mathematics, which is an integral part of geometry, astronomy, navigation, and engineering understanding. Traditionally, the practical potential of trigonometry is often unpredictable in primary education. At the same time, the field of measurement and machine-defined digital revolution as a science of determining the number of physical events, is still in the classical instances of education and application.

In this context, an innovative method of practical trigonometry associated with the measurement and reconsideration of the machine is not only necessary, but also essential to adjust education to contemporary

**Corresponding Author:* Vinit Sachaniya, General Manager-Business Development, Synergy Mechanics Pvt Ltd, Thane, Maharashtra, India.,
Email: vinitsachania@gmail.com, ORCID: https://orcid.org/0009-0004-0604-4271

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

technical and inter-need. This introduction aims to revive traditional trigonometric policies through practical, real-world applications. In the measurement system, modern innovations—especially digital equipment, sensors, and smart devices—are the basis for both academics and industry to form a new form of trigonometry and education. Coordination of trigonometry education and next-generation instruments in hand-pen provides a structure to solve mathematical literacy, critical thinking, and inter-subject problems, especially in science, technology, engineering, and mathematics.

Background & Context

Traditional instances: Restrictions and challenges

For many centuries, trigonometry has been taught through the Euclidean geometry lens, which is often limited to the right-angle triangle, single circle, and sine, cosine, and tangent ratios. Although these theoretical structures are mathematically elegant, educational methods often lack immediate relevance for students. This isolation is especially visible in secondary education, where students fight to attach trigonometric identities to the application of real life, thereby realizing trigonometry as an abstract or even unnecessary subject (Showenfeld, 2002).

Similarly, the field of measurements and instruments is mainly presented in terms of classical physics-Liver Arms, analogue meters, and basic thermal systems. Although effective, this method fails to capture the complexities of the modern machinery system powered by a microcontroller, real-time sensor, and artificial intelligence. The hardness of the curriculum that separated mathematics from the technical branch in hand-pen, resulting in the opportunity to apply mathematical reasoning in the context of engineering (Akarman and Bakkar, 2011).

Why an innovative approach is needed?

Contemporary society claims professionals who can reduce the gap between theory and practice. In cases such as civil engineering, robotics, architecture, and space, the triangle plays an important role in determining distance, angle, and energy. However, without a strong understanding of how these principles are measured, applied, and verified by the machine, professionals may lack the design of complex systems and applicable insights necessary to solve the problem.

In addition, the rapid integration of smart devices, Internet of Things (IoT) platforms, and automatic machines requires a rewrite of measurement concepts and teaching. For example, LIDAR sensors, accelerometers, and GPS modules depend on the acquisition of complex trigonometric algorithms and real-time data for specific

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

measurements. By knitting these modern instruments into trigonometry teaching, we can make the subject more attractive and relevant (Movney, 2020).

Revision of the instrument: from analogue to an intelligent system

Instrumentation, which was once confined to analog voltmeters and physical rulers, has undergone an earthquake change with the digital revolution. Modern instruments include electronic distance meters (EDM), ultrasonic sensors, optical encoders, gyroscopes, and AI-based diagnostic equipment. These instruments are extremely accurate, real-time, and allow automatic measurements. However, their effective use is still dependent on a strong understanding of the underlying trigonometric models — the stages, angles, or periods related to physical events (Dobeline and Manik, 2011). Innovative education must include hand-pen experiments with such instruments, which enable students to program the calibration, explanation, and even measurement instruments. For example, the angular velocity and displacement can destroy complex trigonometric applications using an Arduino-based setup or Raspberry pie platform with zero-scopic sensors (Banji and Shiloh, 2014).

Thus, we can turn trigonometry into a formal, spatial logic and quantitative analysis of science in combination with sophisticated teaching techniques, contemporary measurements, and cross-applications. In addition to improving the educational results, this change will create a generation better suited for innovating, problem solving, and discussing the complexities of today's technical environment.

By integrating innovative educational methods, modern measurement equipment, and inter-subject applications, we can transform trigonometry into a formal, spatial logic and quantitative analysis of science. This change will not only improve the educational results but will also build a generation that is more ready to innovate, solve, and navigate the complexities of a modern technical context.

Review of Literature

The evolution of trigonometry and measurement methods is deeply involved with technical progress, educational reforms, and scientific discoveries. However, despite the significant progress in both cases, the educational practices around them are mainly in traditional. In recent years, literature has focused on the reform of trigonometry education and the reorganization of the techniques of contemporary STEM and the reorganization of the techniques of the machine to better align the real-world enforcement and digital integration. This literary review synthesizes the main contributions to establishing the context and

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

requirements of innovative, inter-subjective, and practical methods from educational research, engineering education, technology-like education, and instrument studies.

Traditional trigonometry: Theory vs. theory

Practice Classy trigonometry has been criticized for additional emphasis on abstract theorem and symbolic causes, which are often disconnected from physical context or sensitive experiences (Showenfeld, 2002; Naradi and Stuord, 2003), in spite of its implementation, physics and engineering.

Harrel & Suder (2005) point out that many students can handle trigonometric identities, but there is a lack of conceptual understanding of angles, periodicity, and the relevance of real life. Similarly, Cinclare and Bruce (2015) point to the absence of the dynamic tool in the trigonometry direction, causing less busyness and holding.

Educational Change: From methodical to experienced education

Modern education theorists and practitioners have called for a change in constructive and experimental models of learning systematic mathematics. According to the Experimental Learning Theory of Kolb (1984), students can learn more effectively through practical experience and reflected observation. In trigonometry education, it refers to the use of mobilized software, physical examination, and field work to make mathematical relationships relevant.

Ainley and others. (2006) question "Purposeful Task Design", where students explore geometric relationships using digital technology and real-world challenges. Their research has shown that students developed the skills to solve more powerful problems when trigonometric problems were embedded in the physical or engineering context, such as ramp designing or analysing speed.

Technology-enhanced trigonometry instruction

A significant part of the literature supports the use of digital equipment to teach trigonometry more effectively. GeoGebra, Desmos, Matlab, and Wolfram Mathematica Sign and Cosine Function, Single Circle and Angle Converters are shown to improve visualization, interaction, and understanding.

Yerushalmi and Shortz (1993) discovered that the dynamic software helps students understand the impact of parameters on the trigonometry functions, promoting a graphical understanding instead of depending on

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

algebra. Dembi (1997) has shown that students using simulation equipment have shown a better understanding of wave behavior and phase the necessary ideas for both mathematics and engineering machinery.

The integration of Augmented Reality (AR) and Virtual Reality (VR) further enhances the ability to represent spatial relations and motion in trigonometry. For example, Kaufman and Smalstig (2003) have informed students to get higher education among students using the 3D environment to understand the geometric and trigonometric structure.

Context-based education and STEM integration

Context-based education has attracted the content of abstract mathematics as a method of applying and applying. Prince and Felder's research (2006) emphasized that problem-based education, when the stem was integrated with the domain, comprehended understandability, cooperation, and critical thinking increased significantly.

Clements and Batista (1990) mention that many students fight the spatial logic key skill in trigonometry because of the disconnection from the context of the world. However, the introduction of the built-in trigonometry in architecture, robotics, or environmental observation helped to internal the students' trigonometry application. In inter-subject models, trigonometry is often taught through robotics (using servo motor and angular sensor) through architectural (roof slopes and structural design) and even music (wave frequency and harmonics), which emphasizes that mathematical relationships manage various events (Pepper, 1980).

Rewrite about measurement: from analog to smart machinery

Measurement and machinery have developed from the manual strategy to the sophisticated system associated with the acquisition of microcontrollers, sensors, and digital data. However, the education system is slow to adopt these innovations. Doebelin and Manik (2011) emphasized the critical importance of the measurement system in all engineering and physical sciences and called for a strong educational focus to understand the behaviour, calibration, defect analysis, and system integration.

Rewrite about measurement

From analog to smart machinery, Measurement and machinery have developed from the manual strategy to the sophisticated system associated with the acquisition of microcontrollers, sensors and digital data. However,

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

the education system is slow to adopt these innovations. Doebelin and Manik (2011) emphasized the critical importance of the measurement system in all engineering and physical sciences and called for a strong educational focus to understand the behavior, calibration, defect analysis, and system integration.

Literature indicates that understanding of measurements does not just mean reading values, but also explaining data generated by a system, such as ultrasonic sensors, gyroscopes, LIDAR, and optical encoders. These tools help reduce the gap between mathematical theories and physical observations that are integrated with education.

Research by Bransford et al. (2000) shows that when students collect and analyze the actual information using portable instruments, they are more deeply aware of the concepts of measurements. Similarly, Chao and Chen (2009) suggested a "smart learning environment" where students used the Arduino kit to measure the distance, angle, and force of the world using trigonometry calculations.

Measure, uncertainty, and digital accuracy

Another important field in the study is related to the intriguing accuracy and uncertainty within the measurement system. Understanding the uncertainty of measurement in engineering and scientific literature is basic (Taylor, 1997), although trigonometry provides the right value to the ideal models, the actual measurements are affected by censorship resolution, environmental noise, and human error.

According to Beverly and Robinson (2003), through practical examination, students create critical skills in explaining information confronted by this uncertainty, model validation, and experimental logic. It creates an opportunity to discuss the statistical and possible aspects of the measure, which is often overlooked in conventional trigonometry education.

Instrumentation in Applied STEM Education

The recent trend towards hands-on engineering education involves in implementing microcontroller-based platforms (E.G., Arduino, Raspberry PI) at low cost, programmable instrumentation setups. Literature shows that incorporating these platforms in trigonometry and measurement systems encourages higher busyness and skills development.

Tarek and Hisham (2017) integrated ultrasonic sensors with Arduino microcontrollers to teach students about angular measurements and distance estimates. Students apply trigonometry principles to calculate the position of the object and compare the results calculated with sensor outputs, thereby having a rich discussion on accuracy, calibration, and real-world deviation.

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

Similarly, Borne and others. (2013) Angular displacement describes the use of a MEMS gyroscope in education. Students not only code the instruments, but also analyze the angular change of the ongoing system-combining the trigonometric modelling and real-world equipment.

Requires restrictions and integration of current research

Despite the growing collection of studies on innovative education and instruments, literature still shows division. Some studies systematically integrate the trigonometric instruction with a hand-pen measure in an uninterrupted curriculum. Further, there is a lack of longitudinal studies to measure the impact of such integrated educational models on long-term understanding, efficiency development, and STEM career interest.

In addition, education reforms, especially in developing areas (UNESCO, 2022), are often interrupted due to resource constraints, teacher training gaps, and curriculum of curriculum. For example, scalable, low-cost interventions as DIY Instrumentation Kit, smartphone-based trigonometry equipment, and mixed education platforms are the main areas of research and implementation.

In the literature, the need for the modernization of trigonometry and measurement education has been emphasized the need to modernize and relevant. By embedding trigonometry ideas in experimental, inter-subjective, and technically enhanced education environments, teachers can develop deep understanding, critical thinking, and relevance.

At the same time, the modern equipment-sensor to the microcontroller, which is integrated in the mathematical instructions, provides the skills and insights required for the students to manage the real-world measurement system, calibration, and analysis. The review research strongly supports the combination of practical trigonometry and innovative measurement education, as well as highlighting the necessary fields of more experienced validity and curriculum.

Research Methodology

This study exploits a qualitative, explanatory research system that emphasizes the teaching of the student's busyness, the student's busyness, and the deep understanding of the directional design and the measurement system. In terms of inter-subject and educational focus, a multi-system design was used for innovation, educational equipment, and theoretical model analysis through document analysis, expert interviews, and classroom observation.

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

Research design

The research has adopted an exploratory case study design (Yin, 2018) that is ideal for investigating how trigonometry is taught and applied in various contexts such as secondary schools, technical institutions, and engineering education environments. This design allows the detection of patterns, educational techniques, and innovations in the environment of pure education.

Information Document Analysis

Current documents, curriculum, teachers' manual, and national educational structure were analysed in the United States, Finland, India, and Australia, which are integrated with the triangular and measuring stem education. Top publishers 'textbooks and teachers' guides were reviewed to emphasize the application-based trigonometry.

Expert interview

A semi-structured interview with engineering colleges, vocational institutions, and adtec institutions was taken a semi-structured interview with academics, curriculum designers, and educational technicians. The questions focus on challenges, innovative equipment and trigonometry instruction, and the best practice of training instruments.

Classroom Observation

Four pilots of observation information were collected from the classroom by applying context-based or mixed trigonometry lessons. Its purpose was to check how students are involved in equipment like GeoGebra, Arduino sensor and angle measuring kit and how to increase the conceptual understanding of the instruction.

Theoretical Framework

An effective integration of practical trigonometry and modern measurement methods must be supported by strong educational and cognitive theory. This section outlines the main structures that inform the innovative directional design of trigonometry and instruments.

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

Structural theory

The centre of educational reform in mathematics is structuralism, the theory that students actively generate knowledge through experience instead of the adoption of knowledge (Piaz, 1952; Vygotsky, 1978) in the context of trigonometry and instruments.

Students create mathematical meaning by measuring the real-world angles and distances using sensors and equipment. Learning through interesting with the physical system is deeper, as the angular speed is measured using gyroscopes. The problem-solving is turned into a cooperative and relevant activity, not just a personal cognitive act. The Constitution also supports scaffolded learning, where tools such as GeoGebra or Arduino provide a slow learning curve to understand code-level from visual manipulation (Pept, 1980).

Experimental Learning Model (Kolb)

Coalber (1984) Experimental Learning Bike is the basis of vocational STEM education. Includes models: Concrete experience (E.G., set up a digital inclinometer) Reflective observations (E.G., compare to counting and sensor-based results) Abstract concept (E.G., connect to analysis of errors with trigonometry modelling) Active test (E.G., a sensor coding to track real-time angular displacement) Physical experiences include trigonometry concepts, students complete this teaching cycle by transforming abstract ideas into applicable knowledge.

Technical Educational Content Knowledge (TPACK)

The TPAC K Model developed by mixed and cool (2006) emphasizes the integration of three domains: Content Knowledge (CK) Trigonometry Function, Identity and Geometric Features Educational knowledge (PK) effective instructional methods, work design, difference Technical Knowledge (TK) Censors, Simulation, Data Logar and Coding platform use T. P. A. C. A teacher in K can create a learning experience where students are: Measure the real-world angles using a mobile app Analyze their results with trigonometry formulas. Reflect the source of error and practical life applications.

Positional teaching theory

Profit and Wenger (1991) argue that knowledge is best achieved in an authentic context. When trigonometry is taught in the structure of a real project-such as the construction of bridges, solar tracking, or land survey,

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

students are involved in legitimate peripheral participation, and the professional community is involved in relevant learning skills.

Equipment plays an important role here. Using digital caliper, ultrasonic sensor or laser rangefinder, students not only learn mathematics, but also achieve a "technical practice" relevant to engineering and technical career (Bordeau, 1986).

Cognitive load theory

Technology integration can deepen learning, but it also risks increasing cognitive load if it is not structured with caution (Souleler, 1988). Coding, circuit setup, and calculations can overwhelm students.

Thus, innovations should be followed by "effective examples", where students first monitor the model of trigonometry using the machine before getting involved in independent work. Simply interface, such as drag-and-drop coding in Tinker Cad or block-based programming, helps reduce cognitive friction (Censher et al., 2006).

Embodiment

Recent literature also suggests that mathematical arguments based on sensorimotor experiences (Lakf and Nunez, 2000) can stimulate spatial awareness to adjust the rolling machines or lasers, which help to internal to the students' sine and cosine.

For example, rotating a gyroscope and monitoring the variety of angular rates strengthens how trigonometric functions are tied to the real rotation system-enhances motor-science busyness in the Sheikh process.

Connection and Digital Network

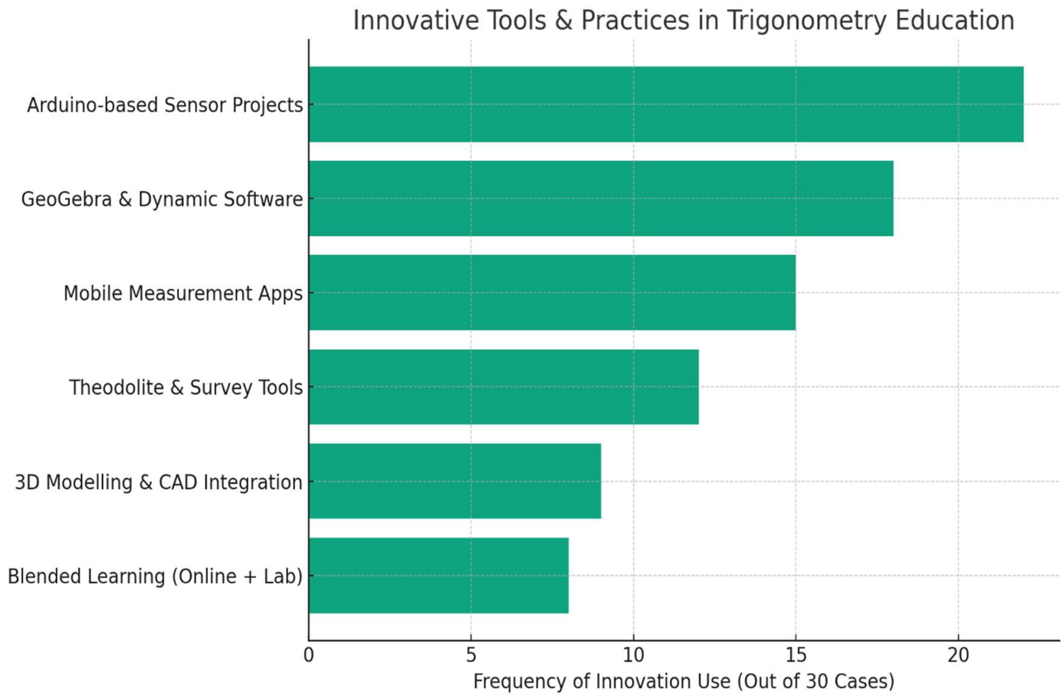
In the context of digital institutions and IoT-based measurement, Siemens (2005) suggested a learning theory for the connectivism-digital age. Open-source platforms, co-coding, and online simulation equipment, trigonometry, and measurements are increasingly being learned, where students create knowledge in network-based ecosystems.

Students came. I. D. A. and the activities can be imitated; the Arduino can access the dataset from the forum and take the code from the GitHub to imagine trigonometric patterns in real-world data.

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

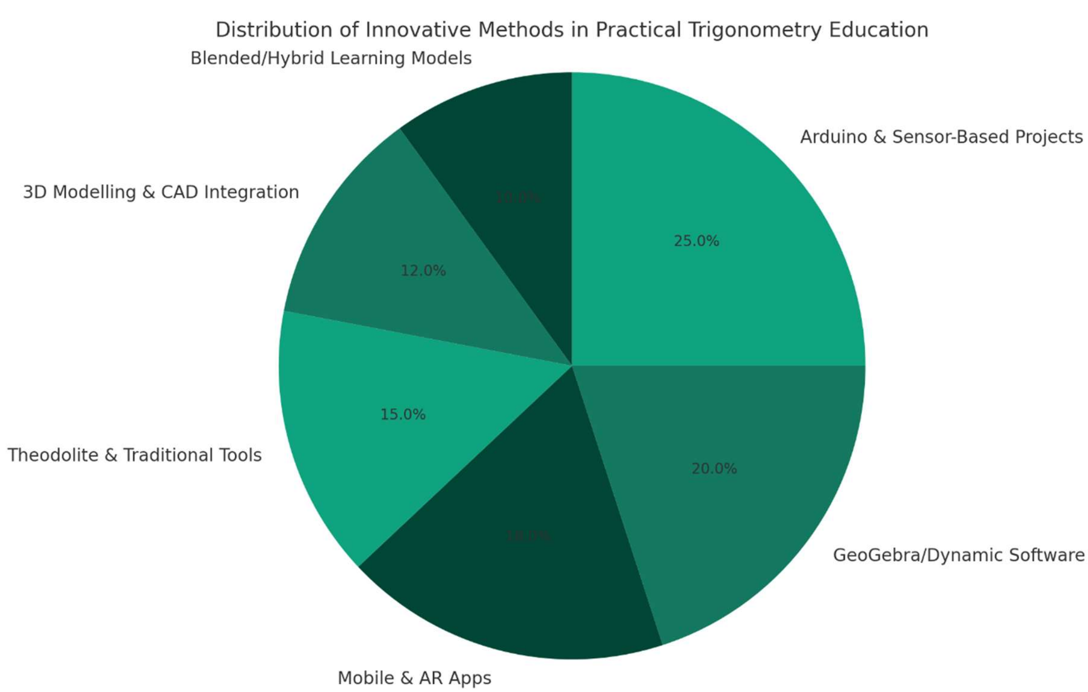
Finding & Innovations

Innovative Tools & Practices in Trigonometry Education



It depicts the Frequency of the Arduino Censor Project, GeoGebra Software, and Mobile Applications in Practical Trigonometry Instruction.

Distribution of Innovative Methods in Practical Trigonometry Education



ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

Innovation Category	Description	% Share
Arduino & Sensor-Based Projects	Use of microcontrollers (e.g., Arduino, Raspberry Pi) for real-world trigonometric measurements (e.g., height, angles, slopes). Projects often involve ultrasonic sensors, tilt modules, and data logging tools.	25%
GeoGebra/Dynamic Software	Interactive mathematical software that lets students manipulate shapes, angles, and waveforms in real-time. Enhances spatial visualization and proof skills.	20%
Mobile & AR Apps	Apps such as Theodolite®, Measure®, and AR Protractor allow real-time measurements and angle tracking using smartphone cameras and sensors.	18%
Theodolite & Traditional Tools	Still crucial in surveying and technical education, these tools are paired with modern validation methods. Reinforces manual skills and measurement discipline.	15%
3D Modelling & CAD Integration	Use of software like SketchUp or AutoCAD to teach angular design, slope measurement, and engineering applications of trigonometry.	12%
Lended/Hybrid Learning Models	Combines virtual simulations (e.g., PhET, Tinker cad Circuits) with physical experiments, especially effective in remote learning contexts.	10%

Discussion and Implementation

Discussion

The research recommends its cognitive limit in trigonometry education and advises an example by integrating contemporary resources such as 3D modelling software, digital theodolites, Arduino-based sensors, and smartphone applications. Trigonometry becomes a physical and visual learning experience with this approach, which reinstates the theory with reality. In addition to their re -re-introduction with contemporary equipment, it also investigates the past measuring techniques, which provides cultural praise and historical depth. In the

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

twenty-first century, the study promotes multi-divisional cooperation by associating mathematics with physics, geography, computer science, and engineering design for students to develop technical fluidity and problem-solving skills.

Implementation

A periodic, modular implementation model is recommended to transform this innovative method into educational practice and technical training:

- **Curriculum Purpose:** Reorganization of secondary and third education trigonometry units to include measuring modules in hand-pen.
- **Purpose of equipment and infrastructure assistance:** Providing basic equipment to schools and universities.
- **Teacher Training and Inter-Cooperation:** To increase the teacher's skills in different branches.
- **Purpose of evaluation reform:** Change in performance-based evaluation from learning in the Ratt.
- **The purpose of participating in communities and industrie**s: To associate the knowledge of the classroom with professional practice.

Conclusion

This study renews the traditional borders of trigonometry by presenting a practical, intra-interior, and technically integrated approach that aligns the theoretical concepts to the application of the real world. Challenging the conventional view of trigonometry as an isolated, abstract mathematical field, the research shows its unused potential in critical fields such as civil engineering, architecture, geology, astronomy, and navigation.

By taking modern measurements with digital theodolite, Arduino-based sensors, and mobile applications, this study shows how trigonometric policies can be made more practical and attractive. The use of such technology encourages active education, improves spatial and analytical thinking, and eliminates the interval between abstract formulas and field-based problems.

The inclusion of historical measurement strategy enriches the educational experience by providing context and continuity, while on the other hand, the proposed hybrid model-traditional equipment integrates with digital innovation, also providing the structure of overall and accessible education. This model encourages experimental education, enhances inter-subject cooperation, and develops technical literacy, which is especially necessary in the world in a world with increasing interrelated and digital mediation.

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

Finally, this study contributes to the revival of trigonometry education, transforming it into a strict academic practice to practical, interactive, and preparing for the future. By hand-pen search, solving relevant problems, and promoting technical integration, it prepares both students and professionals to address the challenges of the world with mathematical confidence and creative insights.

References

Akkerman, S. F., & Bakker, A. (2011). Boundary crossing and boundary objects. Review of Educational Research, 81(2), 132–169.

Ainley, J., Pratt, D., & Nardi, E. (2006). Connecting engagement and focus in pedagogic task design. British Educational Research Journal, 32(1), 23–38.

Banzi, M., & Shiloh, M. (2014). Getting started with Arduino: The open source electronics prototyping platform. Maker Media, Inc.

Craig, J. J. (2005). Introduction to robotics: mechanics and control. Pearson Education.

Doebelin, E. O., & Manik, D. N. (2011). Measurement systems: Application and design. McGraw-Hill Education.

Keller, B. A., & Hirsch, C. R. (1998). Real-world investigations for mathematics and science. Glencoe/McGraw-Hill.

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. Prentice-Hall.

Langley, L. M. (2010). Practical astronomy with your calculator or spreadsheet. Springer.

Ainley, J., Pratt, D., & Nardi, E. (2006). Connecting engagement and focus in pedagogic task design. British Educational Research Journal, 32(1), 23–38.

Bevington, P. R., & Robinson, D. K. (2003). Data Reduction and Error Analysis for the Physical Sciences (3rd ed.). McGraw-Hill.

Boaler, J. (2016). Mathematical Mindsets: Unleashing Students' Potential through Creative Math, Inspiring Messages and Innovative Teaching. Jossey-Bass.

Bourne, J., Carter, D., & Braithwaite, N. (2013). Teaching angular displacement through MEMS gyroscope experiments. International Journal of Engineering Education, 29(5), 1275–1284.

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). How People Learn: Brain, Mind, Experience, and School. National Academy Press.

Chao, C.-M., & Chen, Y.-H. (2009). Smart learning environments for mobile students. International Journal of Information and Education Technology, 1(1), 36–41.

Clements, D. H., & Battista, M. T. (1990). The effects of logo on children's conceptualizations of angle and polygons. Journal for Research in Mathematics Education, 21(5), 356–371.

Demby, A. (1997). Algebraic procedures used in problem-solving. Educational Studies in Mathematics, 33(1), 45–70.

Doebelin, E. O., & Manik, D. N. (2011). Measurement Systems: Application and Design (5th ed.). McGraw-Hill Education.

Harel, G., & Sowder, L. (2005). Advanced mathematical thinking. In L. D. English (Ed.), Handbook of International Research in Mathematics Education. Routledge.

Kaufmann, H., & Schmalstieg, D. (2003). Mathematics and geometry education with collaborative augmented reality. Computers & Graphics, 27(3), 339–345.

Kolb, D. A. (1984). Experiential Learning: Experience as the Source of Learning and Development. Prentice-Hall.

Nardi, E., & Steward, S. (2003). Is mathematics T.I.R.E.D.? A profile of quiet disaffection in the secondary mathematics classroom. British Educational Research Journal, 29(3), 345–367.

Papert, S. (1980). Mindstorms: Children, Computers, and Powerful Ideas. Basic Books.

Prince, M. J., & Felder, R. M. (2006). Inductive teaching and learning methods. Journal of Engineering Education, 95(2), 123–138.

Resnick, M., et al. (1996). Computer as paint brush: Technology, play, and the creative society. IBM Systems Journal, 35(3.4), 433–451.

Schoenfeld, A. H. (2002). Making mathematics work for all children. Educational Researcher, 31(1), 13–25.

Sinclair, N., & Bruce, C. D. (2015). New opportunities in geometry education at the primary school. ZDM Mathematics Education, 47(3), 319–329.

Tarek, A., & Hisham, S. (2017). Low-cost ultrasonic sensor projects in STEM education. Journal of Technology Education, 29(1), 42–54.

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

Taylor, J. R. (1997). An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements. University Science Books.

UNESCO. (2022). Global Education Monitoring Report: Technology in Education. UNESCO Publishing.

Yerushalmy, M., & Schwartz, J. L. (1993). Seizing the opportunity to make algebra mathematically and pedagogically interesting. Educational Studies in Mathematics, 24(2), 183–199.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101.

Creswell, J. W. (2014). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (4th ed.). SAGE Publications.

Patton, M. Q. (2015). Qualitative Research & Evaluation Methods (4th ed.). SAGE Publications.

Yin, R. K. (2018). Case Study Research and Applications: Design and Methods (6th ed.). SAGE Publications.

Bourdieu, P. (1986). The forms of capital. In Richardson, J. (Ed.), Handbook of Theory and Research for the Sociology of Education (pp. 241–258). Greenwood.

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. Prentice Hall.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work. Educational Psychologist, 41(2), 75–86.

Lakoff, G., & Núñez, R. (2000). Where Mathematics Comes From: How the Embodied Mind Brings Mathematics into Being. Basic Books.

Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge University Press.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework. Teachers College Record, 108(6), 1017–1054.

Papert, S. (1980). Mindstorms: Children, Computers, and Powerful Ideas. Basic Books.

Piaget, J. (1952). The origins of intelligence in children. International Universities Press.

Siemens, G. (2005). Connectivism: A learning theory for the digital age. International Journal of Instructional Technology and Distance Learning, 2(1), 3–10.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12(2), 257–285.

ANANYAŚĀSTRAM:
An International Multidisciplinary Journal
(A Unique Treatise of Knowledge)
ISSN : 3049-3927(Online)

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

Ahmad, R., Ismail, A., & Yusof, M. (2019). Using Arduino in engineering mathematics: Trigonometric application in a measurement project. Journal of Technical Education and Training, 11(2), 35–41.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. Applied Developmental Science, 24(2), 97–140.

Gok, T. (2014). Students' achievement, skill and confidence in using GeoGebra in mathematics learning. Procedia - Social and Behavioral Sciences, 116, 292–296.

Hohenwarter, M., & Lavicza, Z. (2007). Mathematics teacher development with ICT: Towards an international GeoGebra community. The Mathematics Enthusiast, 4(2), 47–56.

Mokhtar, M., Yusof, M., & Sahran, S. (2021). Real-world Measurement with Arduino: Lessons in STEM-based Mathematics. International Journal of Emerging Technologies in Learning, 16(12), 102–110.